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Management and sustainability: Creating shared value in the digital era

20-21 June 2019

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Full Papers

a cura di

Alberto Pastore, Federico Testa, Gennaro Iasevoli e Marta Ugolini

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Al Lettore,

questo volume accoglie i full paper del Convegno Sinergie-SIMA 2019 *Management and sustainability: Creating shared value in the digital era*, Sapienza Università di Roma, Roma, 20-21 giugno 2019.

La sostenibilità è senza dubbio uno dei temi sfidanti dell'epoca contemporanea. Lo sfruttamento delle risorse naturali legato alla crescente domanda di beni e servizi ha messo in evidenza quanto i modelli economici esistenti siano limitati. Un sistema di produzione e consumo basato su una logica lineare ove le risorse naturali sono estratte e trasformate per la produzione di beni e servizi è chiaramente non sostenibile. Inoltre, l'iniquità sociale, la povertà, e la fame nel mondo sono problemi sociali che devono essere globalmente affrontati.

Lo scopo del Convegno è discutere dei modelli di business sostenibili e delle necessarie evoluzioni strategiche come sfide per la gestione dell'impresa nel prossimo futuro. Un focus particolare è rivolto allo sviluppo di modelli di business e strategie basate su paradigmi di co-creazione di valore e alle opportunità oggi offerte dalle tecnologie digitali.

Alberto Pastore, Federico Testa, Gennaro Iasevoli e Marta Ugolini

Cari Lettori e Convegnisti,

il *call for paper* del Convegno Sinergie-SIMA 2019 *Management and sustainability: Creating shared value in the digital era* ha previsto la possibilità di presentare *extended abstract* oppure *full paper*. In totale sono pervenuti in redazione 102 *extended abstract* e 51 *full paper*.

Per gli *extended abstract*, la valutazione dei contributi ricevuti è stata operata dal Comitato Scientifico in base alla coerenza con il tema del Convegno e/o con gli studi management secondo i Gruppi Tematici SIMA, alla chiarezza e alla rilevanza (anche potenziale) dei contenuti proposti.

Per i *full paper*, la procedura di valutazione dei contributi è stata condotta secondo il meccanismo della *peer review* da parte di due referee anonimi, docenti universitari ed esperti dell'argomento, scelti all'interno dell'Albo dei Referee della rivista *Sinergie*.

In particolare, i referee hanno seguito i seguenti criteri nella valutazione dei contributi:

- chiarezza degli obiettivi di ricerca,
- correttezza dell'impostazione metodologica,
- coerenza dei contenuti proposti con il tema/track del convegno e/o con gli studi management,
- contributo di originalità/innovatività,
- rilevanza in relazione al tema/track del convegno e/o agli studi management,
- chiarezza espositiva,
- significatività della base bibliografica.

L'esito del referaggio ha portato a situazioni di accettazione integrale, accettazione con suggerimenti e non accettazione. In caso di giudizio discordante la decisione è stata affidata alla Direzione Scientifica. Ogni lavoro è stato poi rinviato agli Autori completo delle schede di referaggio per la valutazione delle modifiche suggerite dai referee, verificate in seguito dalla Redazione della rivista *Sinergie*.

A seguito del processo di valutazione sono stati accettati 41 *full paper* e 97 *extended abstract*, pubblicati in due distinti volumi. In questo volume dedicato ai *full paper*, i contributi sono articolati nelle seguenti gruppi:

- *Management and sustainability: Creating shared value in the digital era*
- *Management studies*

Tutti i *full paper* di questo volume sono stati presentati e discussi durante il Convegno e pubblicati *online* sul portale della rivista Sinergie (***www.sijm.it***).

Nel ringraziare tutti gli Autori per la collaborazione ci auguriamo che questo volume contribuisca a fornire un avanzamento di conoscenze sui modelli di business sostenibili e sulle necessarie evoluzioni strategiche come sfide per la gestione dell'impresa nel prossimo futuro.

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Management and sustainability: Creating shared value in the digital era

How to collaboratively create shared-value? The role of crowdfunding in NPOs

MARIA CARMEN LAUDANO * LAMBERTO ZOLLO• CRISTIANO CIAPPEI♠ VINCENZO ZAMPI**

Abstract

Obiettivo della ricerca. *Una delle sfide più importanti per le organizzazioni contemporanee, sia for-profit che non-profit, è creare valore condiviso nell'era digitale. In questo contesto, il crowdfunding è emerso come una forma di finanziamento alternativa ed interessante per promuovere la sostenibilità delle organizzazioni non-profit (NPO), creando valore sociale ed economico condiviso. Basandosi sulla norma della reciprocità e sulla teoria della motivazione funzionalista, viene presentato un modello concettuale che scorpora la relazione tra la motivazione generale a donare e l'intenzione futura a reiterare la donazione.*

Metodologia. *L'analisi è effettuata su un campione di 129 donatori operanti attivamente su piattaforme digitali di crowdfunding delle cosiddette fondazioni bancarie - una tipologia specifica di NPO localizzate in Italia. L'analisi fattoriale confermativa (CFA) è stata usata per validare il modello proposto. Le relazioni ipotizzate sono state testate empiricamente usando un modello di equazioni strutturali (SEM).*

Risultati. *La gratitudine prosociale - una forma di reciprocità positiva - ed il comportamento di impegno civico risultano essere mediatori significativi della relazione tra la motivazione generale a donare dei donatori e la loro intenzione a reiterare l'atto stesso di donare.*

Implicazioni. *I risultati ottenuti forniscono alcuni insights interessanti sull'uso delle piattaforme digitali di crowdfunding atte a diffondere il cosiddetto valore condiviso nelle organizzazioni stesse e nella società in generale. I managers delle NPs - come ad esempio delle fondazioni bancarie da noi analizzate - dovrebbero investire in levi strategiche atte ad incrementare negli utenti sia la reciprocità positiva che l'impegno civico, per consolidare il flusso di donazione e, dunque, aumentare dunque l'efficacia stessa di tali piattaforme di crowdfunding.*

Originalità dello ricerca. *Il crowdfunding basato sulla donazione sta ricevendo una crescente attenzione da parte della letteratura di management e dei cosiddetti 'practitioners'. Innanzitutto, questa è una delle poche ricerche che esplora questo fenomeno in Italia. Inoltre, lo studio offre un'analisi esplorativa dei meccanismi psico-sociali - ad oggi scarsamente investigati - sottostanti la motivazione dei donatori a donare e a reiterare l'atto. Dunque, in conclusione, saranno illustrate alcune nuove idee riguardanti lo sviluppo socio-economico delle NPO e del Terzo Settore.*

Parole chiave: *crowdfunding; gratitudine prosociale; impegno civico; intenzione a ri-donare; motivazione generale a donare.*

Objectives. *Creating shared value in the digital era increasingly represents one of the most important challenges for contemporary for-profit and non-profit organizations (NPOs). In this context, crowdfunding has emerged as an interesting platform to gather financial resources and foster the sustainability of NPOs by creating social and economic value. Building on the norm of reciprocity and functionalist motivation theory, a conceptual model is presented unpacking the relationship between motivations to donate and future intention to re-donate.*

Methodology. *Data were collected from a sample of 129 donors actively operating on digital crowdfunding platforms of a particular type of NPOs, namely bank charitable foundations, located in Italy. Confirmatory factor analysis (CFA) was used to validate the proposed model. The hypothesized relationships were empirically tested using structural equation modelling (SEM).*

Findings. *Prosocial gratitude - a form of positive reciprocity - and civic engagement behavior resulted as significant mediators of the relationship between donors' general motivation to donate and their future intention to re-donate.*

Practical implications. *The findings provide interesting insights on the use of digital crowdfunding platforms aimed at diffusing shared-value in organizations and in the society in general. Managers of NPOs such as bank charitable foundations should invest in specific strategic levers, i.e. positive reciprocity and civic engagement, to improve the effectiveness of donation-based crowdfunding.*

Originality of the study. *Donation-based crowdfunding is increasingly receiving attention by management literature and practitioners. Focusing on the psycho-social mechanisms explaining donors' motivation to donate, this paper offers an explorative analysis of these scarcely investigated mechanisms. Hence, novel insights to the socio-economic development of nonprofit organizations (NPOs) and the Third Sector are provided. Moreover, this is one of the few researches exploring the phenomenon of donation-based crowdfunding in Italy.*

Key words: *civic engagement; crowdfunding; general motivation to donate; intention to re-donate; prosocial gratitude*

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1. Introduzione

Uno dei concetti più importanti elaborati nella letteratura di management degli ultimi dieci anni è quello della creazione del valore condiviso (Porter e Kramer, 2011). Nell'era digitale odierna tale fenomeno sta assumendo una rinnovata attenzione (Curley e Salmelin, 2018; Salido-Andres *et al.*, 2018). La creazione di valore condiviso comporta l'incorporazione di una missione sociale nella cultura aziendale e la decisione di impiegare risorse specifiche allo sviluppo di innovazioni che possano aiutare a risolvere i problemi sociali. In accordo con le recenti ricerche di diversi autori (Da Cruz, 2018; Felipe, 2015), le organizzazioni che intendono intraprendere iniziative di valore condiviso dovrebbero avere una fondamentale e fondante competenza, esperienza e conoscenza per ottenere il necessario riconoscimento sociale nelle comunità in cui sono radicate; tutto ciò richiede la definizione di un chiaro scopo sociale, la sua divulgazione interna ed esterna e l'integrazione in processi fondamentali come la pianificazione strategica e il budget. Questo stabilisce una cultura che fa emergere il meglio dei dipendenti e aiuta a mobilitare partner esterni che hanno obiettivi simili. (Dembek *et al.*, 2016; Pfitzer *et al.*, 2013) Creare valore condiviso, infatti, è una nuova forma di coinvolgimento delle organizzazioni nelle comunità di riferimento e tale scelta strategica può portare alla crescita e alla sostenibilità economica per differenti tipi di organizzazione, in entrambi i settori for-profit e non-profit (Blewitt, 2008; Elliott, 2012).

In questa ricerca ci soffermeremo su un tipo particolare di organizzazioni non-profit (NPO), ovvero le cosiddette fondazioni bancarie (Leardini *et al.*, 2013). Oggigiorno i bisogni e le aspettative dei cittadini restano spesso insoddisfatti per l'inefficienza dei governi e delle organizzazioni for-profit, i cosiddetti "*government/market failures*" (Davies, 2015; Lee *et al.*, 2016; per una review completa sull'argomento Weisbrod, 1998) e ciò è colmato proprio dall'attività delle NPO (Zollo *et al.*, 2017). Dato il conseguente sviluppo esponenziale dell'imprenditorialità del Terzo settore e la recente diffusione su scale globale delle NPO (Bruton *et al.*, 2015; Shumate *et al.*, 2018), abbiamo ritenuto importante focalizzarci sull'individuazione di nuove forme di finanziamento per supportare l'attività di questo tipo di organizzazioni senza scopo di lucro, basandoci sulla loro capacità collettiva di creare valore condiviso attraverso l'integrazione sociale (Choy & Schlagwein, 2016; Zollo *et al.*, 2018). Il crowdfunding diventa così un modello alternativo ed innovativo di finanziamento delle attività non-profit, supportandone la sostenibilità stessa e la creazione del valore condiviso (Stiver *et al.*, 2015); in particolare, le piattaforme digitali di crowdfunding giocano sempre più un ruolo chiave nel mettere in campo un numero continuamente in crescita di iniziative civili e nuovi sviluppi del Terzo Settore (Baumgardner *et al.*, 2017), garantendone una maggiore diffusione e beneficio per l'intera comunità (Sokolova e Perez, 2018).

Il nostro punto di riferimento di partenza è che l'analisi del settore non-profit stimola nuove ricerche soprattutto nel momento in cui si considera che i destinatari sono non solo utenti che beneficiano del servizio offerto ma anche finanziatori dei progetti ricercando così, pur se in termini diversi rispetto alla classica relazione di compravendita, un beneficio 'indiretto' (Bruton *et al.*, 2015; Shumate *et al.*, 2018; Weisbrod, 1998). Nello specifico, dall'analisi della letteratura pertinente (Zollo *et al.*, 2016), è emerso un gap relativo alle motivazioni, attitudini, intenzioni e comportamenti di coloro che finanziano i progetti delle NPO.

Date queste limitazioni, il presente studio si sofferma su una particolare categoria di finanziatori quali i donatori delle piattaforme digitali di "donation-based crowdfunding" - ossia una forma di finanziamento basata sulla donazione di risorse finanziarie a sostegno di specifici progetti socio-comunitari (Hernando, 2016; Lee *et al.*, 2016) - al fine di proporre e testare un nuovo modello concettuale, costruito sulla teoria funzionalista di Clary *et al.* (1992) con alcuni *insight* della norma della reciprocità (Gouldner, 1960; Hu *et al.*, 2011). Nel paragrafo successivo, per poter approfondire il dibattito scientifico su questo filone di ricerca, forniremo un inquadramento teorico del tema di riferimento, sviluppando le ipotesi che poi saranno testate empiricamente nel terzo paragrafo. Ne seguirà la discussione dei risultati e successivi riferimenti ai limiti della presente ricerca e i possibili sviluppi futuri.

2. Inquadramento teorico e sviluppo delle ipotesi

2.1 Il fenomeno del finanziamento collettivo per donazione

In linea con quanto emerge da numerosi studi del settore (Belleflemme e Lambert, 2014; Ordanini *et al.*, 2011; Schwienbacher e Larralde, 2010), il crowdfunding è una forma di finanziamento senza intermediari in cui diverse persone partecipano collettivamente al finanziamento di un'attività di business e/o ad un progetto non-profit. Il fenomeno del finanziamento collettivo è una via alternativa per superare le difficoltà di accesso al credito, per riempire il gap tra le risorse disponibili dalle istituzioni finanziarie tradizionali e il bisogno finanziario delle organizzazioni che non sempre possiedono tutti gli stringenti requisiti di accesso al credito (De Buysere *et al.*, 2012).

Ci sono diversi modelli di finanziamento collettivo e tutti si caratterizzano come una sorta di banca di investimento in forma virtuale (Mollick, 2014). Attraverso il crowdfunding, si ha una sorta di democratizzazione del capitale, collegando il capitale alla comunità: gli utenti delle piattaforme digitali di crowdfunding non investono solo sui rendimenti finanziari ma anche sugli impatti sociali/ambientali, oltre che sui loro interessi personali (Baumgardner *et al.*, 2017). La valutazione del valore condiviso del crowdfunding rispetto alla nostra economia attuale produce un'immagine unica; l'aumento della competizione su tali piattaforme sta avvantaggiando l'intera economia. Il crowdfunding, infatti, non solo sta riducendo il costo dei crediti, fornendo stabilità finanziaria alle piccole e medie imprese, ma alleggerisce l'incertezza economica stimolando i meccanismi attraverso i quali le banche tradizionali e gli investitori forniscono l'accesso al capitale, essendo così costretti ad innovare, ridurre i costi e aumentare l'efficienza (Baumgardner *et al.*, 2017; Gajda e Mason, 2013)

Nel nostro studio ci siamo focalizzati sul "donation-based crowdfunding", una forma poco studiata in cui diversi donatori contribuiscono, con piccole quantità di denaro, a finanziare progetti che non sarebbe stato possibile intraprendere con altre forme di finanziamento maggiormente strutturate (Hernando, 2016; Lee *et al.*, 2016; Sokolova e Perez, 2018). Infatti, andando alla radice del fenomeno, il crowdfunding basato sulle donazioni può essere considerato paragonabile al microfinanziamento. I requisiti per assicurarsi denaro non sono rigorosi quanto quelli utilizzati da altri istituti finanziari e l'importo del finanziamento richiesto può essere inferiore al prestito minimo disponibile presso una banca; ciò nonostante bisogna sottolineare come, spesso, l'importo finale raccolto attraverso tale piattaforma superi di gran lunga l'obiettivo iniziale ricercato.

Ne consegue che questo tipo di finanziamento sta assumendo una grande risonanza in ambito della sostenibilità delle imprese non-profit, aiutando le organizzazioni ad essere attente alla realtà della comunità in cui operano. Infatti, secondo la teoria del valore condiviso di Porter e Kramer (2011), il successo di qualsiasi organizzazione, comprese dunque le NPO, è influenzato dal sostegno delle comunità circostanti. Dato che il crowdfunding basato sulle donazioni aiutano a ridurre l'inefficienza degli intermediari finanziari e a promuovere attività sociali, la letteratura pertinente percepisce ciò come valore condiviso (Baumgardner *et al.*, 2017; Felipe, 2015; Sokolova e Perez, 2018). Da questa prospettiva, la flessibilità delle le piattaforme digitali di crowdfunding consentono che il rapporto tra NPO e donatori ammetta la creazione di valore per entrambi, e di conseguenza per la comunità in generale, provvedendo a diffondere la qualità e valutare la fattibilità dei diversi progetti. Si può dunque notare una sovrapposizione tra i temi di ricerca legati alla creazione di valore e sostenibilità delle organizzazioni ed il fenomeno del crowdfunding (Mollick, 2014).

2.2 I meccanismi psicologici sottostanti la donazione: motivazioni, reciprocità ed impegno civico

Generalmente il fenomeno del crowdfunding è stato ampliamente studiato da una prospettiva finanziaria mentre, seguendo un'ottica manageriale, possiamo individuare solo un ristretto numero di ricerche riguardanti i meccanismi psicologici sottostanti il fenomeno di finanziamento collettivo

(Brown *et al.*, 2017). Nello specifico concentrandoci - come affermato precedentemente - sul crowdfunding basato sulla donazione per la sua concreta rilevanza nelle economie odierne in base a recenti studi sul tema (Curley e Salmelin, 2018; Salido-Andres *et al.*, 2018), in questa ricerca approfondiremo il fenomeno stesso della donazione, interrogandoci su quali siano quelle variabili che impattano sulla propensione a reiterare l'atto stesso di donare. Ciò è alla base dell'originalità del nostro lavoro dato che, ad oggi, gli scholars si sono focalizzati prevalentemente sulla donazione come output, indagando quali possano essere le diverse variabili input che incidono sul fenomeno.

Nel nostro studio la motivazione a donare è misurata attraverso un adattamento della cosiddetta scala VIF che, originariamente riguardante il volontariato, è composta da diverse sottodimensioni (Clary e Snyder, 1999) raggruppate in due categorie principali coerenti con gli studi precedenti sul tema (Caillé, 1998): motivazioni altruistiche, dunque orientate agli altri (Zollo *et al.* 2017; Clary e Snyder, 1999), e motivazioni 'self-oriented', che quindi spingono alla ricerca dell'auto-protezione e/o valorizzazione, della crescita dell'Io e dello sviluppo personale (Clary *et al.*, 1998). Dato che la definizione stessa di volontariato è basata sull'atto generico di donare - nello specifico offrire aiuto, tempo e capacità (Okun *et al.*, 1998) -, abbiamo traslato la scala VIF al nostro caso di donazione di denaro attraverso una piattaforma digitale di crowdfunding.

Le diverse dimensioni motivazionali utilizzate riescono a ben rappresentare il fenomeno (Clary. e Snyder, 1999; Omoto e Snyder, 1995), comprendendo: (a) i valori personali che esprimono filantropia e generosità verso gli altri; (b) i valori sociali che, invece, manifestano in che misura il compiere donazioni sia legato all'immagine e all'inserimento dell'attore nella società in cui vive; (c) le motivazioni legate ad una più profonda comprensione del proprio Io, per mettere in pratica anche quelle capacità più recondite che altrimenti resterebbero inespresse; (d) le motivazioni che fungono da riparo per i propri sensi di colpa per aver più doni e risorse rispetto agli altri; (e) le motivazioni che spingono ad atti mirati ad accrescere la stima e la fiducia in sé stessi.

Tradizionalmente la ricerca manageriale sul comportamento delle donazioni, basandosi sulla cosiddetta teoria funzionale delle motivazioni (Clary e Snyder, 1999; Okun *et al.*, 1998), ha ampiamente creduto che la motivazione generale precede le intenzioni ad un dato comportamento. Tale teoria infatti è stata utilizzata con una certa regolarità in analisi motivazionali di diversi fenomeni cognitivi, affettivi, comportamentali e interpersonali (ad es., Cantor, 1994; Omoto e Snyder, 1995) ed afferma che l'insieme di valori, credenze e atteggiamenti che costituiscono la motivazione generale ad agire è una delle principali variabili predittrici del comportamento stesso (Webb *et al.*, 2000; Wilson, 2000). Quindi, se ci focalizziamo sull'analisi di coloro che hanno già una volta donato su piattaforme di crowdfunding, possiamo dedurre che proprio tutte le loro attuali credenze, valori e atteggiamenti sottostanti l'atto stesso di donare siano correlati e dovrebbero prevedere le intenzioni a reiterare la donazione (Clary *et al.*, 1998; Wilson, 2000), portando così alla nostra prima ipotesi:

H1. La motivazione generale dei donatori a donare è positivamente correlata con l'intenzione a reiterare l'atto di donazione.

Inoltre, da un'analisi dettagliata della letteratura pertinente, suggeriamo due variabili mediatrici che spieghino questa prima relazione ipotizzata. Infatti il nostro studio trae ispirazione dal lavoro di Clary *et al.* (1998) per capire quali sono le motivazioni antecedenti di una data intenzione, nello specifico reiterare la donazione presso piattaforme di crowdfunding ; al fine di traslare questo modello concettuale nell'ambito poco esplorato delle fondazioni non profit di origini bancarie, abbiamo fondato l'elaborazione delle ipotesi da verificare empiricamente sulla cosiddetta norma della reciprocità (Gouldner, 1960), definita come il meccanismo chiave che determina i comportamenti volontari, in questo caso la donazione. Diversi studi interdisciplinari tra psicologia e management mostrano che le motivazioni, siano essere orientate verso sé stessi e/o verso l'altro, spingono sempre a ricambiare ciò che si riceve (Hu *et al.*, 2011).

Concentrandoci sulla cosiddetta reciprocità positiva, quando gli individui ricevono benefici si sentono obbligati a ricambiare con altrettanti benefici; in particolare abbiamo considerato la

cosiddetta gratitudine prosociale, una forma molto concreta di reciprocità positiva definita come quel sentimento di gratitudine verso la società che, a sua volta, incoraggia un comportamento prosociale e, di conseguenza, accresce lo stesso livello di impegno civico (Zollo *et al.*, 2017). Il sentirsi grati fa sì che i donatori spesso ricevano anche una soddisfazione meramente "interna" e ciò favorisce ancora di più un'ulteriore reciprocità positiva; il comportamento prosociale infatti dà loro un più forte senso della propria identità, evidenziando i loro tratti della personalità 'positivi', quali ad esempio la generosità (Grant e Dutton, 2012).

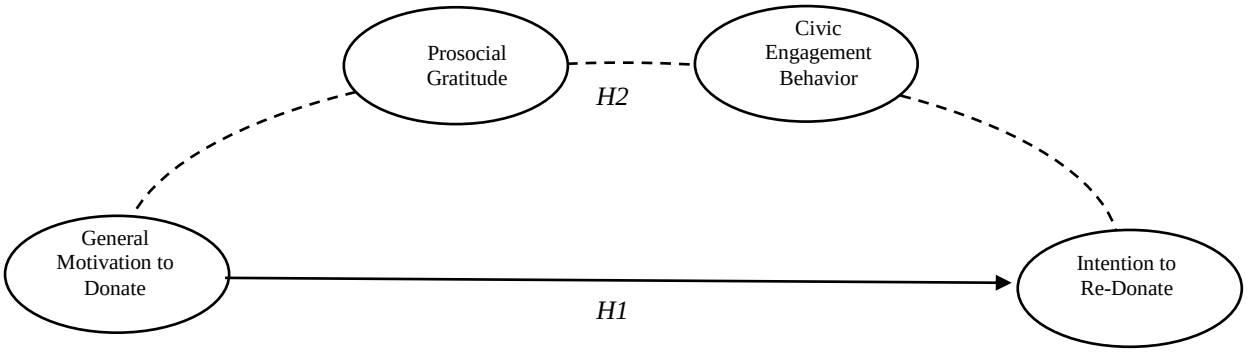
È importante sottolineare come la nostra analisi si soffermi esclusivamente sulle piattaforme di crowdfunding basate sulla donazione, escludendo tutte quelle in cui chi finanzia riceve una qualche forma di ricompensa diretta, in quanto la ricezione può sì generare gratitudine verso i benefattori ma non sempre ispirare la reciprocità e comportamenti prosociali (Esteve *et al.*, 2016; Grant & Dutton, 2012; Yang *et al.*, 2011); infatti la ricezione può generare anche sentimenti di dipendenza e imbarazzo e i riceventi potrebbero voler evitare opportunità di contraccambio. Ne consegue che i donatori - in questo caso gli utenti delle piattaforme di crowdfunding basato sulla donazione - saranno più inclini ad aiutare gli altri, innescando circuiti di reciprocità (Esteve *et al.*, 2016; Faldetta, 2011).

La reciprocità positiva genera integrazione sociale, coesione e senso di appartenenza alla comunità e quindi la persona grata a livello prosociale sarà maggiormente coinvolta a livello civico, come se dovesse restituire un favore alla società o, più nello specifico, alla NPO che, donandole soddisfazione, piacere, realizzazione, aiuto attraverso i suoi progetti, soddisfa le sue aspettative e motivazioni (Mitchell *et al.*, 2001; Molm *et al.*, 2007). Basandoci dunque sull'allineamento tra la complessità della motivazione generale a donare e il fenomeno della reciprocità e quindi delle intenzioni a ricambiare i benefici ottenuti attraverso un maggior impegno civico, ipotizziamo:

H2. La reciprocità positiva e l'impegno civico mediano significativamente la relazione tra motivazione a donare e l'intenzione a ri-donare.

Nella Figura 1, abbiamo sintetizzato le ipotesi, rappresentando la gratitudine prosociale e l'impegno civico dei cittadini come mediatori della relazione tra la motivazione generale dei donatori e le loro intenzioni a reiterare la donazione. In questo modo, analizziamo alcune leve interessanti su cui agire per consolidare il flusso delle donazioni sulle piattaforme digitali di crowdfunding e, di conseguenza, incrementare gli investimenti nei progetti e nelle iniziative non-profit. Testiamo, infine, il nostro modello in Italia, dove c'è uno degli esempi più importanti ed emblematici di crowdfunding digitale, i.e. 'Meridonare' (Gallucci *et al.*, 2018).

Fig. 1: Modello concettuale



Note: *H1*= Ipotesi principale: Influenza della motivazione generale a donare sull'intenzione a reiterare la donazione
H2= Ipotesi di mediazione: La relazione principale è mediata dalla gratitudine prosociale e dal comportamento civico

Fonte: Elaborazione personale degli autori

3. Metodologia

3.1 Campionamento

La cornice di campionamento comprende alcune fondazioni bancarie italiane, ovvero una particolare tipologia di organizzazioni non-profit che giocano un ruolo cruciale nell'attuale contesto socio-economico in Italia. A partire da Giugno 2018 abbiamo sviluppato un questionario contenente 44 items convalidati in letteratura. Usando la procedura della 'back-translation' (Brislin, 1970), abbiamo tradotto dall'inglese all'italiano le domande delle variabili utilizzate. Per controllare la precisione del lessico adoperato e risolvere possibili ambiguità, una versione pilota del questionario è stata testata su un gruppo di 25 studenti che avevano già effettuato in precedenza 'donazioni' di questo tipo; i risultati ottenuti sono stati inclusi nella raccolta dati finale, anche se il pre-test ha rivelato che non vi era bisogno di effettuare alcuna correzione alla survey utilizzata (Laudano *et al.*, 2018).

Inoltre, per evitare il cosiddetto "*common method bias*" (Podsakoff *et al.*, 2003), nella lettera di presentazione del questionario è stato sottolineato come la partecipazione fosse volontaria, anonima e non fosse prevista alcuna ricompensa (Zollo *et al.*, 2017). Grazie alla diretta collaborazione dei presidenti e dei direttori delle principali piattaforme di "donation-based crowdfunding" - come ad esempio "Meridonare", "Rete del Dono", "Eticarim", and "NonprofitLab" - è stato distribuito un link elettronico del questionario da Giugno ad Ottobre r 2018. Con il nostro metodo di campionamento non probabilistico e di convenienza (Etikan *et al.*, 2016), abbiamo ottenuto 129 risposte al questionario, completate da donatori di piattaforme di "donation-based crowdfunding".

Siamo consapevoli delle limitazioni inerenti il nostro metodo di campionamento che potrebbero significativamente inficiare la rappresentatività dei nostri risultati. Tuttavia, gli insight ottenuti da questo primo studio preliminare ci permettono di iniziare ad analizzare le relazioni tra le variabili considerate in una popolazione la cui distribuzione non è nota (Masser *et al.*, 2012), fornendo spunti interessanti per manager delle NPO e ricerche future.

3.2 Scale di misura utilizzate

Ogni scala utilizzata è stata convalidata da studi precedenti che misurano gli stessi costrutti utilizzati in questa ricerca. Tutti gli items sono misurati attraverso una scala Likert da 1 a 7, "assolutamente non importante" (1) e "estremamente importante" (7) (vedi Appendice A).

Motivazione generale a donare. Come già sottolineato in precedenza, la motivazione generale a donare è stata misurata attraverso un adattamento della scala VIF sviluppata da Clary *et al.* (1998; vedi anche Okun *et al.*, 1998). Le motivazioni sono operazionalizzate attraverso 25 items tratte da cinque dimensioni della scala VIF. Clary *et al.* (1998) hanno trovato una alta affidabilità di queste funzioni motivazionali legate a/alla: (a) valori personali (ad es. "Sono preoccupata per coloro che sono meno fortunati di me"; α=0.80); (b) valori sociali (ad es. "Per le persone che conosco bene, donare è un'attività molto importante"; α=0.83); (c) comprensione (ad es. "Donare mi permette di conoscermi meglio"; α=0.81); (d) protezione (ad es. "Donare è una buona via di fuga dai miei problemi"; α=0.81); e (e) sviluppo personale (ad es. "Donare mi fa sentire importante"; α=0.84).

Reciprocità positiva. Questa variabile è stata misurata attraverso la scala sviluppata da Perugini *et al.* (2003) (ad es. "Sono pronta a rimetterci personalmente pur di aiutare alter persone bisognose"; α=0.76).

Impegno Civico. Misuriamo questo tipo di comportamento usando la scala di Doolittle e Faul (2013). La scala, composta da sei items, presenta una stima di affidabilità pari a 0.91 (ad es. "Mi tengo informata sugli eventi della mia comunità").

Intenzione a ri-donare. Questa variabile è stata misurata attraverso una versione adattata della scala di Omoto e Snyder (1995) composta da quattro items (ad es. "Ho intenzione di donare attraverso la piattaforma digitale di crowdfunding nel prossimo anno"). Gli autori hanno ottenuto una stima di affidabilità della scala pari a 0.86.

4. Analisi

4.1 Caratteristiche del campione e analisi di affidabilità

Riguardo le caratteristiche del campione, coloro che hanno risposto al questionario hanno, in media, tra i 30 ed i 39 anni e sono donne per il 53.5%. Poco più della metà (51.9%) sono dipendenti con una laurea triennale o magistrale (55.0%). La Tabella 1 mostra le statistiche descrittive dei singoli item, l'analisi di affidabilità e le correlazioni. Le scale mostrano una buona affidabilità: i valori delle alpha (α) di Cronbach sono tutti superiori a 0.70 come richiesto dalla letteratura (Hair *et al.*, 2006).

Considerando le statistiche descrittive delle variabili analizzate, possiamo osservare che, all'interno della motivazione generale a donare, le diverse sotto-componenti presentano medie molto diverse tra loro, nello specifico la sotto componente della motivazione legata ai valori personali presenta il valore più alto (5.72), mentre quella legata alla protezione del proprio Sé ha valori ridotti quasi della metà (2.77). Questo risultato fa emergere come, all'interno delle diverse piattaforme digitali di "donation-based crowdfunding" ciò che spinge davvero a donare sono propri i valori personali e la propria prodigalità verso gli altri; donare solo per mettere a tacere i propri sensi di colpa appare come una scelta decisamente marginale nell'analisi delle motivazione.

Per quanto riguarda l'analisi di correlazione bivariata, tutte le dimensioni sono correlate significativamente tra di loro, ad eccezione della dimensione motivazionale legata alla protezione del proprio Io che, invece, non è correlata né con il comportamento di impegno civico né con l'intenzione a reiterare l'atto stesso della donazione. La sotto-componente della motivazione che, ancora una volta, risulta avere un peso maggiore nell'influenza sia con l'intenzione a reiterare la donazione che con i livelli di impegno civico, è quella legata ad i valori personali: quando l'essere persone generose e filantrope diventa un elemento fondante della propria identità, inevitabilmente i propri comportamenti rifletteranno un maggior impegno civico e ciò si rifletterà in un maggiore attitudine a donare nuovamente.

Tab. 1: Media (M), Deviazione standard (SD), affidabilità (Cronbach's α) e correlazioni

	Media	***SD***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
1. MGD sviluppo personale	4.32	1.63	*(0.74)*							
2. MGD protezione	2.77	1.73	0.528**	*(0.82)*						
3. MGD sociale	4.41	1.43	0.478**	0.194*	*(0.88)*					
4. MGD comprensione	4.94	1.56	0.636**	0.295**	0.478**	*(0.80)*				
5. MGD valori	5.72	1.29	0.458**	0.153*	0.456**	0.383**	*(0.73)*			
6. Reciprocità positiva	5.42	1.43	0.483**	0.237**	0.568**	0.459**	0.635**	*(0.78)*		
7. Impegno civico	5.17	1.55	0.354**	0.074	0.624**	0.431**	0.375**	0.586**	*(0.87)*	
8. Intenzione a ri-donare	5.27	1.57	0.438**	0.130	0.568**	0.459**	0.635**	0.185*	0.317**	*(0.93)*

Note: I valori della alpha di Cronbach sono riportati in diagonale; MGD: Motivazione generale a donare
*** p < 0.01; * p < 0.05*

Fonte: Elaborazione personale degli autori

4.2 Risultati

Le ipotesi di mediazione sono testate seguendo la procedura proposta da Hayes (2013) usando la macro specifica di SPSS PROCESS (v. 2.16; Preacher and Hayes, 2004; 2008). Per condurre l'analisi di mediazione multipla (modello 6 della macro PROCESS) è stato usato il metodo bootstrapping (basato su 5,000 campioni bootstrap) calcolando gli intervalli di confidenza dei livelli inferiori (LLCI) e superiori (ULCI) intorno alle stime degli effetti indiretti corretti al 95 per cento.

Per quanto riguarda la relazione tra la motivazione generale a donare e l'intenzione a reiterare l'atto stesso della donazione, l'H1 è confermato, mostrando un effetto totale pari a +0.79 ($p<0.01$), con LLCI e ULCI pari a rispettivamente +0.3074 e +0.8749. Dato che l'effetto totale differisce

significativamente dall'effetto diretto (+0.46, p<0.01) - con LLCI e ULCI uguali rispettivamente a +0.1917 e +0.9802; dunque, sia la reciprocità positiva che l'impegno civico risultano mediatori parziali della relazione iniziale ipotizzata, fornendo così evidenza e supporto statistico a H2.

L'analisi empirica ha mostrato che le motivazioni di coloro che hanno già donato almeno una volta su una piattaforma digitale di crowdfunding sono positivamente associate alle loro intenzioni a reiterare la donazione. La scoperta è coerente con la letteratura sulla teoria funzionalista della motivazione (Clary *et al.*, 1992; Clary e Snyder, 1999) e sulla reciprocità (Hu *et al.*, 2011; Gouldner, 1960), mostrando che le motivazioni auto-orientate e orientate verso l'altro hanno un impatto non solo sulle intenzioni a donare ma anche, di conseguenza, sulle intenzioni a reiterare l'atto stesso della donazione.

5. Conclusioni: implicazioni, limiti e futuri sviluppi della ricerca

Come affermato in precedenza, se ad oggi la ricerca sul crowdfunding si è concentrata prevalentemente sugli effetti e sul perché le organizzazioni possano decidere di porre in atto tale tipologia di finanziamento di tipo collettivo, poco invece è stato studiato con riguardo alle motivazioni e alle intenzioni di coloro che partecipano attivamente alle piattaforme di crowdfunding.

Vogliamo contribuire a questo tipo di letteratura integrandola con la ricerca relativa alla norma della reciprocità, ampiamente riconosciuta come essenziale nei contesti organizzativi, soprattutto for-profit (Gouldner, 1960; Zollo *et al.*, 2017). Evidenziandosi così un ulteriore gap nella letteratura di riferimento, abbiamo ritenuto opportuno effettuare questo studio esplorativo nell'ambito del non-profit, sottolineando come la reciprocità dovrebbe far riconoscere la direzione da intraprendere per i managers delle NPO, premiando e incentivando il comportamento di donazione (Faldetta, 2011).

Indubbiamente la ricerca presenta alcuni limiti, sia di tipo squisitamente metodologico legati al metodo di campionamento utilizzato e alla conseguente rappresentatività sul totale della popolazione, sia limiti concettuali dovuti all'inserimento di sole alcune delle variabili che potrebbero essere ritenute chiave in ambito crowdfunding. Nonostante ciò, i nostri risultati forniscono alcune interessanti implicazioni manageriali, facendo emergere, nello specifico, che le stesse organizzazioni non-profit possono essere gestite in modo più efficace e sostenibile rafforzando le percezioni effettive dei servizi offerti alla comunità così che, comprendendo le motivazioni, gli atteggiamenti e i comportamenti conseguenti, la reciprocità positiva diventi una leva su cui agire per influenzare gli investimenti dei donatori (Lehner e Nicholls, 2014; Mollick, 2014).

Pertanto, i manager dovrebbero garantire che le organizzazioni no-profit sostengano, attraverso il crowdfunding basato sulla donazione, progetti atti a promuovere la cultura della reciprocità, un clima di gratitudine prosociale e dunque un maggiore impegno civico, evidenziando il cosiddetto valore condiviso di iniziative simili per tutta la comunità (Da Cruz, 2018; Felipe, 2015). Si tratta, dunque, di recuperare una duplice visione dei destinatari dei progetti delle NPO così che, non solo gli utenti diretti, ma anche coloro che finanziano possano ricevere un beneficio indiretto attraverso un miglioramento della stessa comunità di appartenenza, per il valore condiviso attraverso le attività non-profit. Il valore condiviso del crowdfunding che offre benefici sociali e ambientali non è più limitato alle comunità locali. I valori e i benefici possono inoltre collegare le imprese al mondo incoraggiando la formazione di cluster di competenze e capacità. Un problema sociale o ambientale che si verifica in una regione può essere efficacemente mitigato attraverso questi cluster globali. Inoltre, come evidenziato dalla letteratura pertinente in ambito for-profit (Brown *et al.*, 2017), oggigiorno diverse organizzazioni consolidate hanno iniziato a utilizzare siti web di crowdfunding non solo come fonte di finanziamento, ma anche come piattaforme di marketing. In questo modo, si riesce ad utilizzare le piattaforme come veicoli per incrementare l'immagine della società ed ottenere supporto per cause ad essa legate; l'incremento del flusso delle donazioni diventano il valore condiviso la cui diffusione attraverso piattaforme digitali cresce in maniera esponenziale

rispetto ai canali tradizionali, diventando in tal modo anche stimolo per l'imprenditorialità del Terzo settore e la sua sostenibilità nel tempo.

Sicuramente occorre sottolineare come questo adattamento del crowdfunding per scopi similari a quelli del marketing non sia privo di problemi, tuttavia, le organizzazioni dovrebbero considerare non solo le opportunità offerte da queste piattaforme, ma anche i loro limiti e rischi. In particolare è probabile che la pressione sulle piattaforme digitali di crowdfunding per trovare nuove fonti di entrate e l'entusiasmo delle imprese di entrare in questo nuovo canale cambierà, nel tempo, la stessa industria del crowdfunding nel tempo. Ad oggi infatti, gli utenti di questa forma di finanziamento sono in gran parte attivisti ed appassionati che sostengono cause e progetti locali. Questi non sono il tipo di utenti e consumatori che finanzieranno/compreranno tutto ciò che viene offerto a loro; sosterranno i progetti e le offerte che piacciono a loro, indipendentemente dal nome dell'azienda e dai servizi che la piattaforma di crowdfunding offre loro.

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Appendice A. Questionario utilizzato

Variabile latente	***Item***	***Letteratura di riferimento***
MGD sviluppo personale	- Donare mi fa sentire importante; - Donare accresce la mia autostima; - Donare mi fa sentire utile per la società; - Donare mi fa sentire meglio con me stesso; - Donare mi permette di creare nuove relazioni sociali (con altri donatori o con i beneficiari delle somme)	Adattamento ripreso da Clary *et al.* 1998, Okun *et al.*, 1998, Zollo *et al.*, 2017
MGD protezione	- Donare mi fortifica per affrontare i problemi personali; - Donare è una buona fuga dai miei problemi; - Donare mi fa sentire meno solo; - Non importa se sto vivendo una situazione difficile, donare mi aiuta a dimenticare.	Adattamento ripreso da Clary *et al.* 1998, Okun *et al.*, 1998, Zollo *et al.*, 2017
MGD sociale	- Le persone che conosco donano; - Le persone a me vicine attribuiscono un elevato valore alla donazione; - Le persone a me vicine apprezzano che io dono; - Le persone che conosco condividono l'interesse di donare alla comunità; - Per le persone che conosco meglio, donare è un'attività importante.	Adattamento ripreso da Clary *et al.* 1998, Okun *et al.*, 1998, Zollo *et al.*, 2017
MGD comprensione	- Donare mi permette di sapere di più sulla causa sostenuta; - Donare mi permette di avere una nuova prospettiva delle cose; - Donare mi permette di sviluppare attenzione sulla causa per cui dono; - Donare mi permette di relazionarmi con una varietà di persone; - Donare mi permette di conoscermi meglio.	Adattamento ripreso da Clary *et al.* 1998, Okun *et al.*, 1998, Zollo *et al.*, 2017
MGD valori	- Sono preoccupato per le persone meno fortunate di me; - Sono sinceramente preoccupato per la buona causa che ho sostenuto; - Nutro compassione verso le persone bisognose; - Ritengo sia importante aiutare gli altri; - Donare mi permette di far qualcosa per un progetto o una iniziativa per me importanti	Adattamento ripreso da Clary *et al.* 1998, Okun *et al.*, 1998, Zollo *et al.*, 2017
Reciprocità positiva	- Sono pronto a restituire ad altri i favori che la vita mi ha fatto; - Se ricevo un favore da qualcuno farei tutto ciò che mi è possibile per restituirlo ad altri; - Sono pronto a sostenere costi personali per aiutare altre persone bisognose.	Perugini *et al.*, 2013
Impegno civico	- Sono impegnato nella donazione a favore della mia comunità; - Quando dono provoco cambiamenti positivi nella comunità; - Aiuto le persone bisognose della mia comunità; - Rimango informato sugli eventi della mia comunità; - Partecipo ad iniziative collegate al tema della responsabilità sociale e collettiva; - Contribuisco alle iniziative non profit presenti nella mia comunità.	Doolittle e Faul (2013)
Intenzione a ri-donare	- Ho intenzione di donare nei prossimi 6 mesi attraverso una piattaforma; - Ho intenzione di donare nel prossimo anno attraverso una piattaforma; - Ho intenzione di donare nei prossimi 3 anni attraverso una piattaforma; - Ho intenzione di donare nei prossimi 5 anni attraverso una piattaforma.	Omoto e Snyder (1995)

Multi-sided platform: how digital technology supports collaborative action for sustainable development

GIANLUCA ELIA* ALESSANDRO MARGHERITA•

Abstract

Objectives. *Sustainability is today a key challenge for decision makers and management both in the public and private sectors. Disruptive trends and technologies such as collaborative innovation and digital platforms are creating new opportunities for sharing and pursuing sustainability goals across a wide range of projects and initiatives worldwide. The goal of this article is to derive a conceptual framework of multi-sided platform as a promising paradigm and techno-organizational approach to support sustainable development and the resolution of complex societal issues.*

Methodology. *A design science approach is used to derive the conceptual framework, also based on a specialized literature review. A single case study is adopted to provide an illustrative application of the defined model.*

Findings. *The multi-sided platform presented includes four key dimensions related to what, how, why and who aspects, which are discussed and illustrated also using an application of collective intelligence to identify solutions to the climate change problem.*

Research limits. *The framework needs further theoretical development and practical validation in order to strengthen the robustness of conceptual design and the potential of application in real-life scenarios.*

Practical implications. *The model represents a knowledge platform, which can drive further applications in the field and a management model to support design of initiatives and projects aimed to use multi-sided platform as operational model to improve sustainability.*

Originality of the study. *The main value added of the study is to apply an emerging management paradigm to define new ways of using collective intelligence for enhanced social development.*

Key words: *climate change; collective intelligence; design science; framework; management paradigm; multi-sided platform; sustainable development.*

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1. Introduction

The pervasive penetration of the Internet and digital technologies within business and society allowed the emergence of a new economy characterized by digitalization of processes and information, virtual flows, industry disintermediation, real-time transactions, open innovation, and knowledge centrality (Tapscott 1999, 2014; Castells, 2004), thus amplifying the scale, access and availability of knowledge, and the relationship among individuals and knowledge sources (Presenza *et al.*, 2018). The "digital economy" offers unprecedented opportunities for the renewal of organizations and societies, and a space where individuals and organizations can experiment new forms of collaboration and new ways for solving societal problems, thus contributing to the transition to more sustainable sociotechnical systems (WBCSD, 2010; Seiffert and Loch, 2005; Markard *et al.*, 2012).

In the last decade, thanks to the diffusion of Web 2.0 technologies and the rise of collaborative consumption and collective behavior (Botsman and Rogers, 2011), the digital economy has become the socio-technical platform where individuals and organizations can promote peer to peer access to underutilized goods and services, which prioritizes utilization and accessibility over ownership (Schor and Fitzmaurice, 2015). The "digital sharing economy" has thus emerged as a new paradigm where digital technologies reduce transaction costs and increase social benefits and seamless connectivity between providers who offer services, goods or assets to share and those who intend to receive them (Guttentag, 2015; Frenken and Schor, 2017). The main industries that are greatly impacted by this new paradigm and are growing at exponential rates are equipment rental, B&B and hostels, car rentals, book rental, and DVD rental (Iasevoli *et al.*, 2018). Indeed, exemplary cases of such disruptive trend are companies and initiatives such as Airbnb, Uber, Amazon Mechanical Turk, Taskrabbit, Crowdflower, Lyft, Couchsurfing, Car2go, Relayrides, Cargomatic, Munirent.

The digital sharing economy enhances redistribution, mutualization and shared mobility of resources, goods and services, thus contributing to explore potential pathways for the sustainable development, along the social, environmental and economic dimensions (Schor, 2016; Demailly and Novel, 2014; Martin, 2016). Moreover, one of the biggest potential that the digital sharing economy can bring is related to the capacity to cultivate and activate the business model innovation process within existing organizations and industries (Grieco and Cerruti, 2018).

The US National Academy of Engineering (NAE) has identified a family of grand challenges that address complex issues and wicked challenges such as access to clean water, improvement of urban infrastructures, population ageing, pollution reduction, and enhancement of cyberspace security. West Churchman (Churchman, 1967) has firstly used cases such as global warming, climate change, health care, poverty, education, and crime to introduce examples of wicked problems. More recently, the United Nations have identified seventeen sustainable development goals (SDG) related to a set of universal, integrated and transformational problems that cover global and complex issues such as poverty, nutrition, instruction, sanitation, employment, climate change, preservation of natural resources, and justice (UN, 2015). The UN agenda represents a comprehensive framework of global challenges that countries have to solve in order to achieve a better and more sustainable present and future. At the same time, the UN-SDG framework represents a vast space of opportunity where governments, organizations, companies, institutions, research centers, educational providers, and individuals as well can collaborate to design and experiment innovative solutions to improve health and education, shrink unemployment and inequality, reduce poverty, and boost social growth and economic development (Banerjee and Duflo, 2011; Prahalad and Ramaswamy, 2004).

The attempt to find possible solutions to critical human issues has been a major driver for undertaking research in the field of democratic participation and collaborative decision-making. Societal problems are wicked, and thus not resoluble in the sense of finding definitive and objective answers. Participatory approaches are promoted as effective decision-making processes, and this is line with the tendency to ascribe superior value to decisions when people with different interests, worldviews and values are involved in deliberations (Nogueira *et al.*, 2017). Today, the Internet and

social networking can allow distributed collective intelligence (Lévy,1994; Pór, 1995) and wisdom of crowds (Surowiecki, 2005) to arise as a strategy to solve complex and multifaceted social challenges. A new generation of socio-computational systems or collective intelligence systems (Malone *et al.*, 2010) may allow the harvesting of knowledge and experience possessed by potentially thousands of individuals, thus supporting more robust and shared decisions for the public good (De Liddo and Buckingham Shum, 2014). However, a number of complexities derive from the difficulty to define the state of a multifaceted topic and to generate feasible ideas and effective actions by engaging all the stakeholders that can contribute in devising possible futures. The effectiveness of decision-making relies on the capacity to link the varied contributions of the involved agents, which depend on their different interests, points of view and values, and the way in which the process of decision-making is conducted (Nogueira *et al.*, 2017).

In such scenario, the main research curiosity of this study is related to how digital technologies can support a more robust and performing management of sustainability issues and drive the definition of balanced and effective solutions. In particular, the article analyses the concept of Multi-Sided Platform (MSP) as a techno-organizational model able to bring together two or more distinct but interdependent groups of actors to create value by enabling direct connections and interactions (Osterwalder *et al.*, 2010; Eisenmann *et al.*, 2006). A MSP can support an effective matching between the demand of needs expressed by one or more sides and the offer of solutions provided by the other side(s). Although the MSP model has been already applied into market and business-oriented contexts, there is still limited evidence and experience of applying the paradigm into socially-relevant and sustainability scenarios.

The remainder of the paper is structured as follows. Next section presents the core background of the article, with the analysis of digital sharing economy and sustainable development principles, and the definition of multi-sided platform. The main research process and method applied to the study is presented in section 3. Section 4 presents the findings, with the illustration of the model and its main components. An illustrative application of the model to a real case in the climate change context is then illustrated in section 5. Section 6 concludes the paper with discussion, limitations and avenues for further research.

2. Background

2.1 Digital sharing economy

The explosion of digital technologies such as social networking platforms, big data, and cloud computing (Kenney and Zysman, 2016) has driven the emergence of a digital sharing economy as a technological phenomenon (Hamari *et al.*, 2015), also labeled as ‘digital matching economy’ or ‘platform economy’ (Kenney and Zysman, 2016). The peer-to-peer type of transaction and the networking effect (Cusumano, 2015) have also led to the term ‘peer economy’ (Witt *et al.*, 2015).

The “digital sharing economy” emerged as new socio-technical paradigm and allowed existing and new organizations to design business models characterized by the presence of online sharing activities that affect factor markets (capital, labor) and product markets (goods and services). Besides, these business models benefit of information costs that fell sharply and coordination costs for sharing online activities that drop correspondingly, thus contributing to revolutionize traditional industries such as transportation, accommodation and rental, retail, office space and logistics, finance and consumer credit, and the labor market (Codagnone and Martens, 2016).

By leveraging the logic of servitization that promotes the temporary access to resources, and thanks to the enhanced connectivity boosted by digital platforms, the resulting effect of digital sharing economy scenarios is the possibility to use and redistribute the under-utilized tangible and intangible resources (Maiolini *et al.*, 2018).

Such new economic system includes ICT-enabled economic activities that allow to link people, share resources and promote social cohesion (Böcker and Meelen, 2017) by leveraging five key

processes (Schor, 2016): 1) the recirculation of goods (e.g. Craigslist, eBay); 2) the increased utilization of durable assets (e.g. Zipcar, Relay Rides, Uber, CouchSurfing, Airbnb); 3) the exchange of services (e.g. Time banking, TaskRabbit, Zaarly); 4) the sharing of productive assets (e.g. Floow2, Coursera); and 5) the building of social connections (i.e. Mama Bake, Soup Sharing, and EatWithMe).

The digital sharing economy exhibits a number of distinguishing principles (Pouri and Hilty, 2018; Sutherland and Jarrahi, 2018) such as flexibility in users' participation, mechanisms of digital trust, extended reach of resources/providers/ consumers, and advanced management of transactions. Moreover, distinguishing factors are the inclusion of interpersonal and societal effects, the sharing of tangible and intangible valuable resources, real-time matchmaking, and a tension between a model of centralized control and emergent interactions. As a general principle, the digital sharing economy has a potential to contribute to realize redistribution, reallocation, and sharing of tangible and intangible resources, thus participating to build a more sustainable development and growth (Schor, 2016; Demailly and Novel, 2014; Martin, 2016).

2.2 Collective intelligence and sustainable development

The uptake of the sustainability concept can be traced back to the increasing evidence on global-scale environmental risks, such as ozone depletion, climate change, biodiversity loss or the alteration of the nitrogen cycle (Geissdoerfer *et al.*, 2017). Sustainable development is the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The concept was further expanded at the Earth Summit, Rio 1992 (UNCED, 1992) in the Agenda 21 'Policy plan for environment and sustainable development in the 21st Century'. The 27 principles agreed in the final declaration interweave political, economic, legal, social and environmental dimensions. Today the concept of sustainable development represents a conceptual framework to handle complex, interlinked economic, social and environmental developments (Heinrichs, 2013).

The explosion of social computing has allowed collective intelligence to arise as multi-disciplinary framework to solve problems together with higher effectiveness than individually. Research conducted at the crossroads of collective intelligence and social media can help design appropriate information systems for wicked problems, and this is particularly true given the high level of participation of millions of people in social media environments (Schoder *et al.*, 2014). Collective intelligence systems can be key drivers to explore the future of open, user-centered and democratized innovation (Gassmann *et al.*, 2010; von Hippel, 2005).

Two interesting examples of collective intelligence systems that leverage social networking and expert contribution to support the resolution of wicked problems are Open Ideo (www.openideo.com) and the MIT Climate Colab (www.climatecolab.org) (Introne *et al.*, 2013). The systems tackle social challenges through the creation of a space for community members to contribute, by providing tools and resources for on-line voting, supporting, contributing and expert mentoring in the solution ideation and description endeavor. The key focus is on key actions such as share stories on specific challenges, ideation and community sharing of ideas, idea refinement for designing solutions, community feedback and solutions testing, selection of top ideas and community search for collaborators.

Other examples of tools supporting problem discussion are Compendium (http://compendiuminstitiute.net) for visual mapping and management of ideas and arguments developed by people, CoPe_it! (http://copeit.cti.gr) for argumentative collaboration and decision support, and Debategraph (http://debategraph.org) for supporting individuals and communities to deliberate and take decisions on complex issues. The EU2020 "Catalyst" project is a large-scale research effort aimed to generate and apply open tools for collaborative knowledge creation for public good. It is also useful to mention the CogNexus Institute (working on wicked problems and dialogue mapping) and the Swedish Morphological Society (on wicked problems and social messes).

2.3 Multi-Sided Platform (MSP)

The concept of Multi-Sided Platform (MSP) was introduced at the beginning of 2000 (Armstrong, 2006; Caillaud and Jullien, 2003; Parker and Van Alstyne, 2005; Rochet and Tirole, 2003) to describe a complex socio-technical system enabled by the Internet, which enables direct interactions (and transactions) between two or more customer groups that are affiliated with the platform for accessing to products, services, resources, assets and information (Hagiu and Wright, 2015; Hagiu, 2014). In line with Teece (2018), the term 'platform' is used as mediating transactions between groups of actors, rather than in the sense used in the engineering design literature that focuses on product architectures and components (Gawer, 2014).

A key characteristic of MSP is the network effect, which can be direct or indirect (Hagiu, 2014). The former refers to how increasing the number of participants on the same side, whereas the latter refers to how attracting participants on a side by leveraging the presence of members on the other side(s). A MSP provides support and facilitates interactions (and transactions) among the sides that it serves, such that members of one side are more likely to get on board the MSP when more members of another side do so.

Besides, a MSP operates as a digital business model, organizing coherently resources, activities and the network of partners to generate profit by delivering to customer segments a specific offering with the expected value proposition. A MSP can be interpreted according to multiple views, depending on the theoretical lens that is adopted. For example, by referring to the literature on digital entrepreneurship (Cohen *et al.*, 2017; Giones and Brem, 2017; Nambisan *et al.*, 2017; Shabbir *et al.*, 2016), a MSP is a digital platform that offers a shared common set of services, as well as architectural components, to host complementary offerings and software interfaces that guarantee communication and interoperability (Parker *et al.*, 2016; Tiwana *et al.*, 2010).

By using the lens of complexity theory (Anderson, 1999), a MSP is a set of independent agents whose interactions, on both the same and different sides, influence the behavior and performance of the overall system. Besides, through the development of self-organizing networks, the agents coevolve and the overall system grows through recombination mechanisms and matching functions. Besides, a MSP can be also considered as a digital ecosystem (Dini *et al.* 2011; Li *et al.* 2012; Moore, 1996; Iansiti and Levien, 2004; Gawer and Cusumano, 2002) in which participants, through a self-organized and scalable system, use technologies to interact and exchange information in the ultimate goal to increase system utility and system innovation.

In the digital innovation research stream (Nambisan *et al.*, 2017; Yoo *et al.*, 2010), a MSP can be considered as an emerging and collective organizational form enabled by digital technologies, that involves dynamic sets of actors with diverse goals and capabilities, in which physical and digital components are combined (Yoo *et al.*, 2012), and different user groups mediated by technologies create the direct or indirect network externalities (de Reuver *et al.*, 2018; Katz and Shapiro, 1985), with the potential to transform entire industries.

Referring to the literature on digital business model (Amit and Zott, 2001; Amit and Zott, 2012; Weill and Woerner, 2015), a MSP allows experimenting new configurations of content, structure and governance of transactions by identifying new sources of value and articulating purposefully the value proposition (i.e. the value of the proposed offering), the value architecture (i.e. the configuration of resources and competencies), the value network (i.e. the actors involved in the business through open and closed modes of participation), and the value finance (i.e. the revenue generation and cost structure), with the ultimate goal to monetize innovative value propositions in online markets (Muzellec *et al.*, 2015). Moreover, a MSP can represent the platform upon which developing the customer experience mechanisms and the content, completed by digital information, to design a new digital business model (Weill and Woerner, 2015).

In the last decade, several examples of MSP emerged. Booking.com and AirBnB are platforms that operate in the accommodation industry by facilitating the matching among hotels or dwelling owners with people in search for accommodation. Alibaba.com, eBay, Taobao and Rakuten are online shopping malls that involve retail stores and consumers. In the movie industry, Fandango

connects cinemas and consumers, or Netflix connects movie producers and users. In the entertainment sector, Ticketmaster groups events and consumers. Linkedin can be considered as an example of MSP characterized by the contemporary presence of four typologies of actors (i.e. professionals, companies, recruiters, advertisers) that are attracted by different sources of value. In the mobility industry, Uber facilitates the connection among professional drivers and passengers whereas BlaBlaCar matches travelers driving a mean of transport with passengers in search for mobility service in the final aim to share the transportation cost for all. Facebook is another example of MSP with multiple groups of participants (i.e. users, advertisers, third-party game or content developers, affiliated third-party sites) that receive benefit from their presence upon the system. Other cases are Apple's iOS (connects application developers and users), Google's Android operating system (connects handset manufacturers, application developers and users), eDX or Coursera (connect teachers and learners), Sony's PlayStation or Microsoft's Xbox gaming consoles (connect game developers and users), American Express, PayPal and Square (connect merchants and consumers), Skype and WeChat (connect users and advertisers), and SocietyOne (connects loan requesters and lenders).

With so many platforms, several taxonomies have been proposed for their classification. An interesting contribution has been proposed by Iasevoli *et al.* (2018) who provided a classification based on two key variables linked to the multi-sided perspective (Rochet and Tirole, 2006) such as the value delivered from supply side and the value desired from demand side. The former refers to the kind of access delivered to consumers, and can range from intangible skills and competencies to more tangible goods and services (Codagnone *et al.*, 2016); the latter refers to the main reason why consumers access a particular platform, and can range from rational to social (Lamberton and Rose, 2012). Based on these two variables, Iasevoli *et al.* (2018) introduced four archetypes of platforms. The first one is the *"Utility Job Platforms"*, where the value delivered is in the form of skills and competencies, and consumers are mainly driven by rational motives such as the desire to save money or find smart solutions to their problems (e.g. Sitterlandia.it that connects families with qualified baby sitters, study tutors, care assistants for the elderly, and other professionals in the domestic arena). The second archetype is the *"Collective Creativity Platforms"*, which deliver skills and competencies to consumers that join communities where people share the same interests (e.g. Intertwine.it that realizes the collaborative storytelling where multiple users write pieces of a story). The third archetype is the *"Exchange Property Platforms"*, which provide goods and services to consumers motivated by rational benefits (e.g. Comprovendolibri.it that connects booksellers and private users for selling second hand books). Finally, the fourth archetype is the *"Community Platforms"*, which connects goods and services providers with consumers wishing to participate in the community (e.g. Scambiocasa.com that realizes a home sharing community).

In such cases, the platform acts as a pure matchmaker, without offering or possessing any other additional service or asset. Similar exemplary cases are Uber that acts as a taxi-company without owning any taxi, or AirBnb that operates as an accommodation provider without owning any real estate. The same is for Alibaba, the largest retailer in the world without any inventory, SocietyOne, a bank without capital, or Netflix, a movie house without owning any cinemas.

3. Methodology

The study was based on a preliminary review of relevant literature, which helped to identify the main theoretical constituents of the research. Literature was selected among specialized journals in areas such as research policy, management information systems, innovation management, sustainability and business management. The review of literature was specifically focused in the topic of Multi-sided Platforms and supported the construction of a draft conceptual model to be further specialized in the following of the research process.

Afterwards, a design science approach has been adopted to conceptualize and define the components of the model through the phases of problem identification, objectives definition, artifact

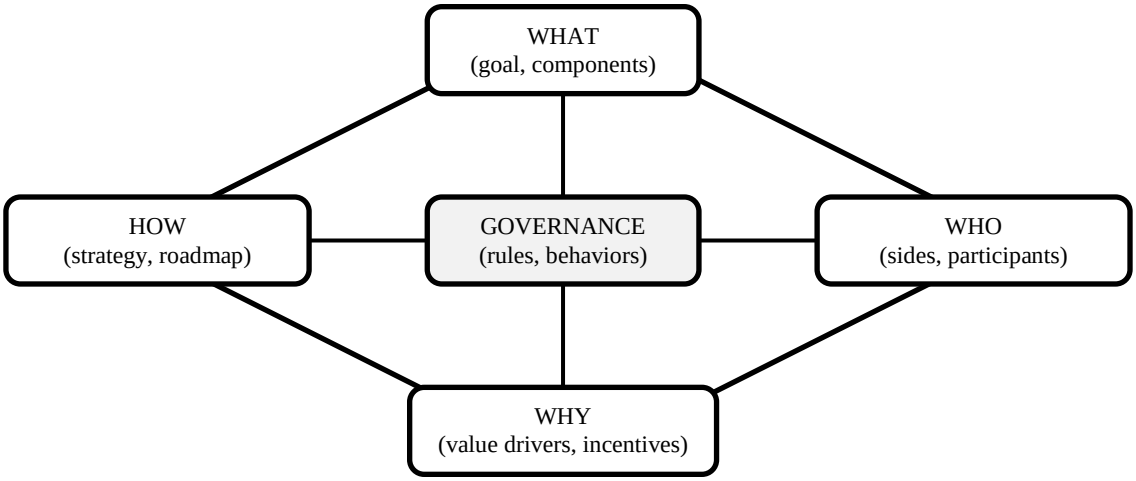
development, solution demonstration, evaluation and research communication. Design science supports a pragmatic research paradigm that calls for the creation of innovative artifacts to solve real-world problems or design and experiment innovative solutions (Hevner *et al.*, 2004; Peffers *et al.*, 2006). In this case, problem identification was focused on the absence of a holistic or integrative framework able to support the sustainable development discourse. The artifact developed is represented by the 4-component model which can be also used a basis for developing technology platforms, applications and information systems. The current article anticipates research communication and new publications will document future complementary research. The model defined was submitted to a preliminary face-validity test undertaken with researchers and experts in the areas of sustainable development and digital ecosystems.

Finally, to provide a description and show an illustrative application of the framework for extrapolating further insights, a single case study has been developed (Eisenhardt, 1989) by looking at the MIT Climate Colab. Case study represents a strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context (Yin, 2003). Case study method is usually chosen for the purpose of the first study since it gives more in-depth analysis of the research problem, more detailed information, and more comprehensive results (Creswell, 2003). The case has been developed by following the typical phases of the research process, which are (Eisenhardt, 1989; Yin, 2003): the definition of the research question, the selection of the case, the identification of the sources for the data collection, the execution of data collection (desk or in the field), the analysis of data, and the preparation of the report. As for the research question explored, it refers to the adoption of MSP as effective model to be applied in sustainable development scenarios. At this purpose, the case of the MIT Climate Colab has been selected since it is one of the most successful and recognized initiative in the domain of climate change, which is a relevant topic in the sustainable development field. The sources for data collection mainly rely on the content and information available on the web site; besides, in order to have triangulation of data they have been integrated by scientific papers published by the founder and sponsor of the initiative, as well as through participatory observation undertaken by the authors through direct navigation of the web platform. The execution of data collection lasted one month and happened in February 2019. All the data have been analyzed through the framework elaborated in this paper, in order to apply it and generate a specific instance for the Climate Colab initiative. The result of data analysis is included in this paper, which represents a preliminary research report documenting the adoption of the MSP model for the design of sustainable development initiatives.

4. Findings

This section presents a model of Multi-sided Platform (MSP), which is assumed as a techno-organizational paradigm able to support awareness building, decision making and actions into the discourse of sustainable management and sustainable development. By adopting a perspective based on collective intelligence (Malone *et al.*, 2010), a MSP can be synthesized into a number of four different dimensions or “genes” related to “what”, “how”, “who” and “why” elements of investigation. Moreover, a fifth additional dimension of system governance should be addressed. Figure 1 shows a snapshot of the MSP model with its distinguishing elements.

Fig. 1: Genes of a Multi-sided Platform



Source: Our elaboration

The *"What"* dimension includes the strategic goals that the MSP aims to fulfill, framed into a more general and comprehensive vision and mission, as well as the key components to put in place in order to let the MSP operate. The strategic goal of the platform is directly aligned with the sustainable development goal that the organization or the community aims to reach. Examples include solutions that may relieve poverty and promote employment and industrialization, facilitate the access to healthcare and education services, mitigate hunger through the promotion of sustainable agriculture, increase access to sanitized water and clean sources of energy. Other sustainable development goals are to diffuse eco-friendly production and reduce the amount of waste, reduce emissions and the impact on climate change, prevent and decrease marine pollution and acidification, combat desertification, reduce violent crime and child abuse. A second aspect to address is related to the components of the MSP, i.e. the constellation of elements and flows to be developed and orchestrated in order to make the MSP operational. They include (Helfat and Raubitschek, 2018; Van Alstyne *et al.*, 2016; Dini *et al.* 2011; Li *et al.* 2012; Iansiti and Levien, 2004):

- number of sides and typologies of participants, i.e. the varied categories of actors that operate on each side of the MSP as service contributors, input suppliers or complementary asset providers;
- aggregation mechanisms, i.e. the value attractors and functionalities through which users can join their sides and interact with actors in the same side as well as in other sides;
- matchmaking function, i.e. the algorithm ensure an effective alignment between the parts involved and the interests expressed;
- interface with third parties, i.e. the link with the MSP core architecture that ensures interoperability with components provided by complementors, partners, and suppliers;
- system of feedback, i.e. the services through which participants can express their judgement towards peers, goods and services;
- digital backbone, i.e. the hardware and software components that allow participants to access to the MSP services.

The *"How"* dimension refers to the overall strategy designed for the setup of the MSP, as well as to the operational roadmap required for its launch. Beside the description of vision and mission, and the identification of the participating targets, the definition of the strategy requires the analysis of the following key issues (Hagiu and Wright, 2015; Hagiu, 2014; Parker and Van Alstyne, 2005):

- direct network effects, i.e. how the platform aims at attracting participants on a side by leveraging the members that already exist on the same side;
- indirect network effects, i.e. how the platform aims at attracting participants on a side by leveraging the presence of members on the other side(s);

- pricing strategy, i.e. how the platform sets prices on each side.

Whereas these issues characterize the static view of the MSP model, the dynamic perspective, should address the set of activities that build the roadmap for the setup and launch of the platform, which includes (Dou and Wu, 2018; Singh, 2013; Jithamithra Thathachari, 2016):

- positioning the MSP into the industry of reference, also based on focus, vision and mission;
- monitoring of participants' categories and related needs;
- reinventing value attractors for each target or side;
- implementing strategies and actions to enhance the direct and indirect network effects (slow and steady, jumpstart, fake it till you make it, bait and switch), and overcome the chicken-and-egg problem;
- tuning of matchmaking algorithms and functions;
- defining the revenue model;
- defining the affiliation model to aggregate third parties members and expand the MSP scope;
- involvement of complementary asset providers and input suppliers to include in the ecosystem;
- maintaining and updating interfaces so to ensure the openness of the platform;
- defining KPIs for monitoring the MSP performance, evaluating the feedback of participants, and communicating the impact on the multiple dimensions of the sustainable development;
- setting up the MSP digital backbone (hardware, software and algorithmic components).

The *"Who"* dimension includes the aspects related to the number of sides involved into the MSP, the target profile for each side, the initial group of people joining the platform, and any possible provider of complementary assets that can contribute to accelerate the startup of the platform. The most successful MSPs are characterized by the presence of two sides (e.g. Uber, Airbnb, eBay), although significant advantages may derive from increasing the number of sides in terms of larger cross-side network effects (e.g. Windows), scale and potentially diversified sources of revenues (e.g. LinkedIn). However, adding new sides can increase management complexities and generate possible conflicts of interest among multiple sides and the MSP. Many MSPs have discovered that they have to offer their services for free or at subsidized prices to at least one side of the platform and derive their profits on the other side (the MSP is thus characterized by one loss-leader side and possibly one or more profit-making sides).

The *"Why"* dimension refers to the value drivers, motivating factors and incentives that bring participants to join the platform and operate actively within the different sides and groups of the platform. Thanks to the (direct and indirect) network effects (Gawer and Cusumano, 2014), the more active participants operate in each side, the greater is the potential value that the MSP can generate for both the participants and stakeholders. In particular, the following capabilities represent key value-drivers and incentives that attract participants into the MSP (Hagiu and Wright, 2015; Hagiu, 2014; Hagiu, 2009):

- resource matchmaking (e.g. price-based, quality-based, reputation-based);
- audience building (e.g. opinions, comments, visibility);
- efficiency seeking (e.g. economy of scale, speed, information symmetry);
- cost reducing (e.g. search costs, transaction costs, new product development costs);
- problem solving (e.g. access to a huge community of potential "solvers" that can propose alternative solutions);
- decision making (e.g. presence of organized explicit or implicit information upon which taking more robust decisions);
- information and knowledge sharing (e.g. availability of a huge amount of information and knowledge shared on the different sides of the platform);
- resource sharing (e.g. access to valuable resources, both tangible and intangible, to increase productivity);
- collaboration and innovation (e.g. search competencies and expertise to promote collaboration for innovation purposes);
- developing awareness on the importance of sustainable development (e.g. responsibility for the

planet, tolerance and peaceful cohabitation, importance of decorous living conditions to guarantee peace and combat the violence);

- tangible and intangible value exchange (e.g. flows of information, knowledge, money and goods, love and glory).

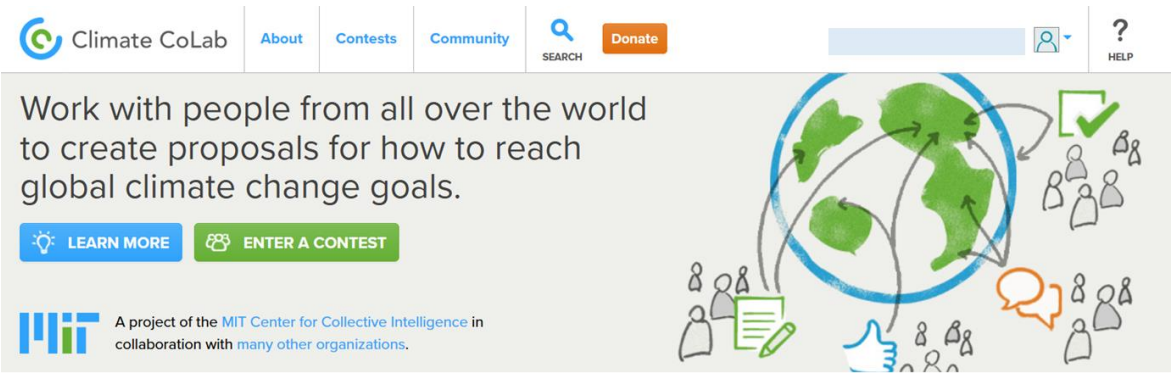
The orchestration of the four components of the MSP requires a proper governance structure, i.e. a set of explicit and implicit rules and behaviors that regulate the affiliation of members on the different sides, the access to and use of the services of the platform, the interactions among the parts involved on different sides, and the incentives to encourage participation. Moreover, once the platform is operative, the governance should consider key issues that can have impact on the growth of the MSP, such as (Hagiu, 2009) quality certification of the offering proposed, diversity of content, financial and human resources constraints, add of new sides, potential conflicts of interest with the MSP ecosystem for the introduction of new functionalities. These aspects are crucial for evaluating possible directions for a further growth and evolution of the platform.

5. A Real Case of MSP for Sustainable Development: the MIT Climate Colab

This section illustrates the application of the MSP model to the real case of a web platform, which is addressed to achieve sustainable development goals, and particularly to find potential solutions to the global problem of climate change. The MIT Climate Colab (www.climatechange.org) is an initiative launched by the MIT Center for Collective Intelligence to harness the collective intelligence of thousands of people from all around the world. The Climate Colab is a problem solving community of people with different background and expertise (scientists, experts, policymakers, business people, practitioners, investors, and citizens), which work together to think constructively about climate change and to define projects, evaluate plans and build effective solutions to the problem.

Within the Colab different categories of participants can propose ideas or projects and build a team that works to co-edit and finalize a valid proposal. People within the community can support ideas and projects using likes and comments, and can join a team to provide suggestions and contributions. All the proposals submitted are grouped into contests, each one with a specific lifecycle that includes an evaluation phase made by experts, and an impact assessment phase made by fellows that estimate the likely impact on climate change. Both steps are crucial to decide which proposals are eligible for the awards. Actually, a committee uses criteria such as novelty, feasibility, impact, and presentation to select the proposals that pass the first judgment step, and provides further recommendations for submitting a more analytical version. The updated versions of proposals are reviewed again, before to meet the entire community that votes and decides the winners. Figure 2 shows the homepage of the Climate Colab initiative, whereas next paragraphs describe the Colab through the key components of the MSP model, i.e. “what”, “how”, “why” and “who”.

Fig. 2: The MIT Climate Colab homepage



Source: www.climatecolab.org

5.1 "What" Dimension of the MIT Climate Colab

The main goal of the Climate Colab multi-sided platform is to contribute to solve the complex societal problem of global climate change. To reach this goal, the MSP involves three "sides" that represent three categories of actors: 1) members who create proposals; 2) members who support a proposal or contribute to the same, and finally vote; and 3) experts engaged to assess proposals. Members are scientists, experts, policymakers, business people, practitioners, and citizens interested to launch an initiative, and give a support or a contribution. They join the platform because they are sensible to the general theme of climate change and they feel they can provide a valuable contribution to a wicked problem that has a relevant societal impact. Actors can use specific functionalities of the platform to create new proposals or to support, share, vote and contribute to existing ones. Matchmaking grounds on searching and browsing contests and project proposals, and finally choosing based on personal competencies and interests. Interfaces with third parties is limited to involve sponsors and collaborators in offline events, where they evaluate proposals, provide feedback, and give funds for their implementation. A system of feedback is represented by the typologies of actions that the community members can do with reference to the proposals, i.e. support, share and vote. The digital backbone of the Colab is represented by a virtual community hosted in the cloud and realized through the Climate Colab Software, which is an open source suite available on GitHub. Figure 3 shows the Climate Colab as a MSP with three sides.

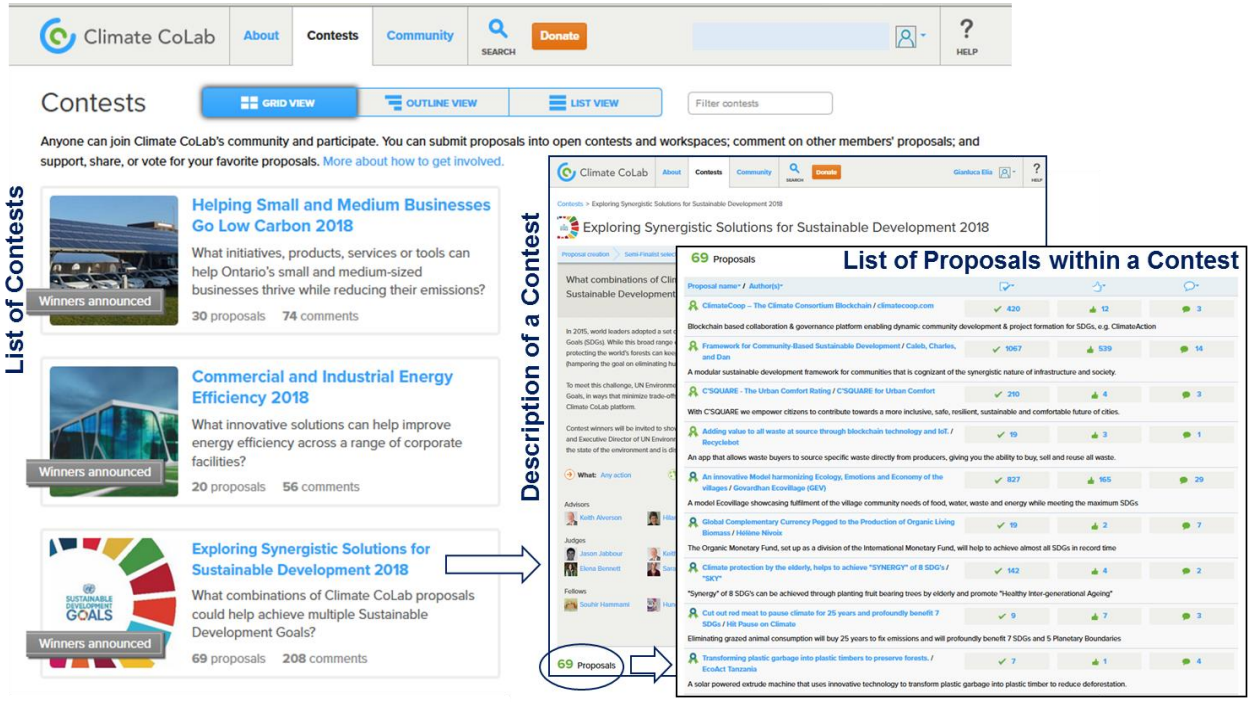
Fig. 3: The MIT Climate Colab as a 3-sided platform (MSP)

Source: www.climatecolab.org

5.2 "How" Dimension of the MIT Climate Colab

The strategy of the Climate Colab leverages the brand of the MIT and the value of its network of sponsors and collaborators to attract participants on each side. Actually, the increasing number of members that submit project proposals into the community attracts experts, scientists and companies that can provide their contribution and enhance the overall quality of proposals (direct network effects). At the same time, this proliferation of valuable proposals and the richness of the community in terms of knowledge and expertise attract and motivate new members to join the platform and provide suggestions and feedback, or create new proposals as well (indirect network effects). The number of advisors, judges and fellows increases accordingly to both the number and complexity of the contributions provided. Since the participation of community members is free, the economic sustainability of the initiative grounds on donations and contributions received from sponsors and collaborators. The dynamic side of the platform is supported by the presence of contests, which represent the virtual and organizational environments where single initiatives and proposals are created, developed, reviewed, enriched, commented, assessed, selected, voted, and awarded. Figure 4 shows the Climate Colab contests and proposals section.

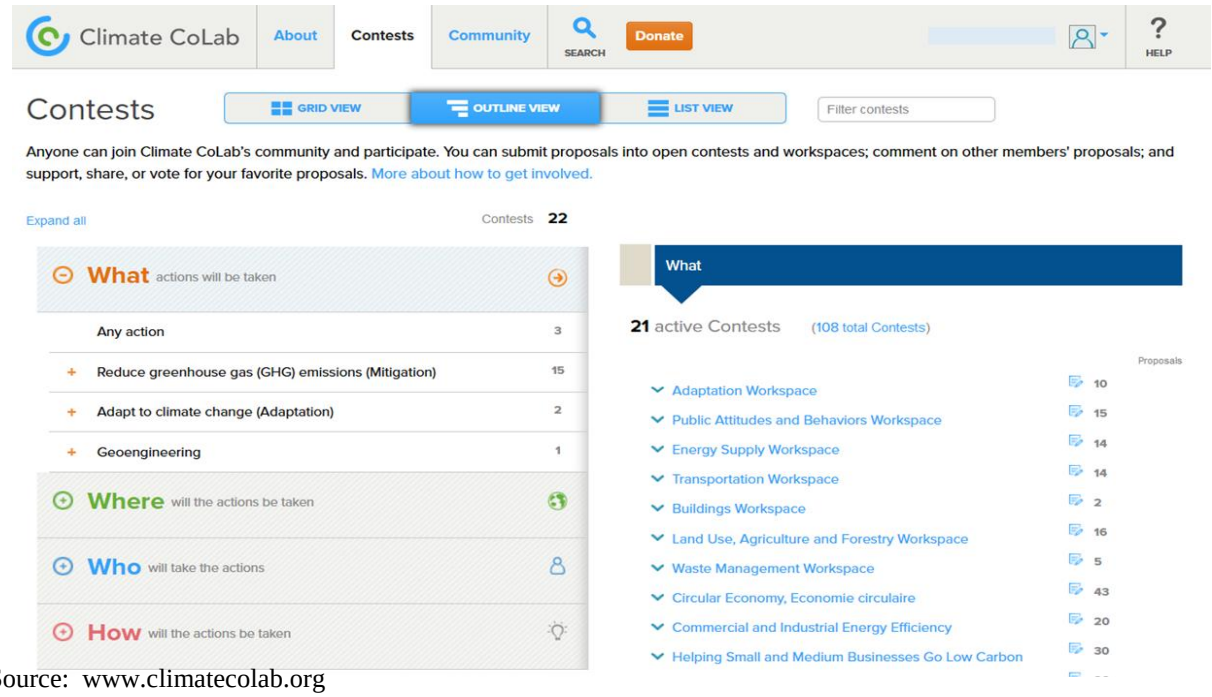
Fig. 4: The MIT Climate Colab contests and proposals section



Source: www.climatecolab.org

Once a contest is closed, the winning proposal represents a potential impactful solution to the climate change problem. The proposal can be broken down into a number of more manageable sub-solutions organized along four key dimensions: a) actions taken to address climate change (e.g. mitigation actions, adaptation actions); b) geographical scale of the intervention (e.g. global level, regional level, city level); c) nature of leadership (e.g. governmental bodies, business organizations, citizen); and d) typology of action (e.g. physical, political, economic, cultural). These dimensions create an alternative way to browse contests and related proposals, in the perspective to group a sub-set of solutions and design more integrated and effective project plans. Figure 5 shows a different view of the Climate Colab contests and proposals.

Fig. 5: Outline view of the MIT Climate Colab contests



Source: www.climatecolab.org

The platform is also promoted through an annual conference and the involvement of the media, which spread out information and news about the MSP, thus attracting more members interested to join the platform.

The functioning of the MIT Climate Colab MSP includes the definition and measurement of a set of indicators to monitor the overall performance of the platform. At platform level, three main indicators are used: the total number of registered members (around 120,800), the total number of proposals submitted (about 2,960), and the total number of contests that group the proposals (109). The values of the three indicators refer to the end of April 2019.

At proposal level, the key indicators used are the number of comments received, the number of votes collected, and the number of supporters. Moreover, a crucial measure of the quality of the proposal is the climate impact, which is calculated by an impact assessment fellow based on the application of ad hoc models and simulators. By aggregating several proposals into a single contest, the same indicators can be used to assess the relevance of an entire contest.

At single member level, two key indicators are used to measure the quality of the participation: the total number of performed actions (e.g. submission of new proposals, joining of proposals, support to existing proposals, comments to existing proposals), and the Colab points reached, which are assigned to winning proposals and distributed among the team members and contributors.

The economic sustainability of the MIT Climate Colab MSP is based on two key revenue sources: a) donations made by participants or web site visitors; b) fees paid by sponsors and collaborators. This allows to ensure free participation of members and to cover the costs deriving from delivery of online and off line services, and the overall maintenance of the community.

5.3 "Who" Dimension of the MIT Climate Colab

The architecture of the Climate Colab MSP includes three sides: 1) people interested to create their own proposals; 2) members willing to support, vote or join existing proposals; and 3) a community of advisors, judges, fellows, impact assessment fellows, and catalysts who are committed to provide feedback, make analysis and enhance the proposals submitted. Whereas the first two sides include people that are generally interested to join the platform and possess an heterogeneous profile or background, the third side includes individuals that are selected and appointed by the CoLab governance, and includes therefore individuals with a significant knowledge and expertise in the climate change domain, with valuable qualifications and strong connections in the field, and the ability to use modeling and simulation tools.

Moreover, to stimulate participation of the first two sides, each year the MIT Climate Colab invites people to submit proposals dealing with challenges and topics that are of interest for sponsors, collaborators and stakeholders. All the three sides of the platform are loss-leader sides since the participation is free for everybody. However, a critical mass of members on the first two sides drives an increase of members on the third side, and the overall mass of users determines the level of attraction of sponsors and collaborators towards the MSP itself, thus contributing to consolidate and reinforce the brand and reputation of the platform itself.

5.4 "Why" Dimension of the MIT Climate Colab

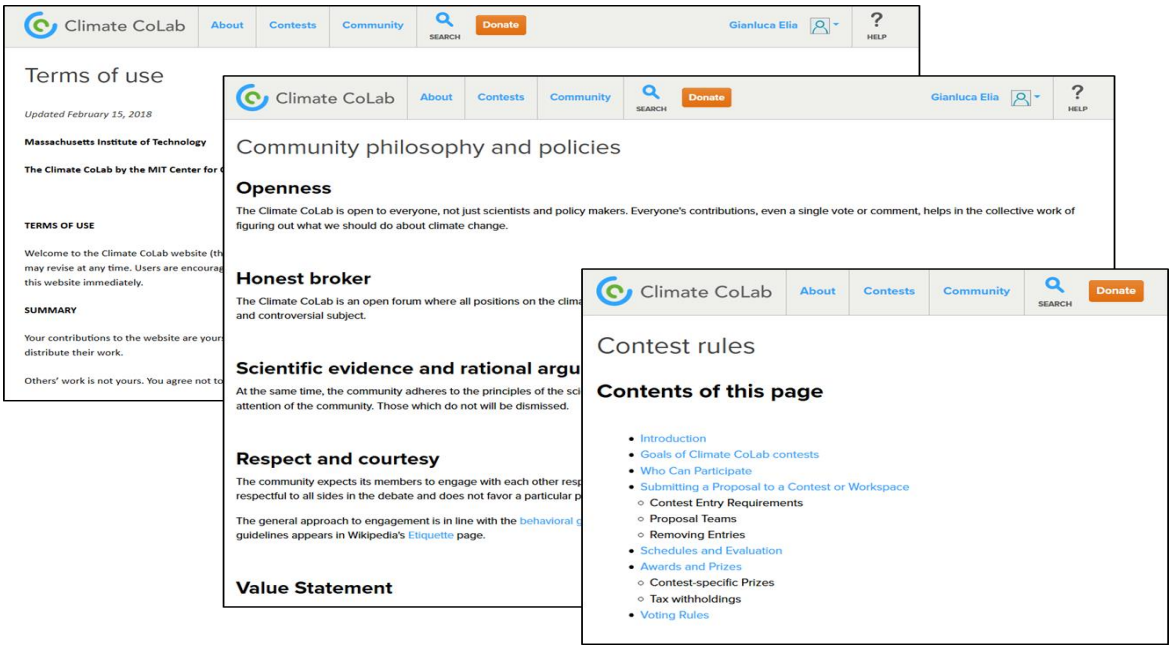
The main principle and value that drives the existence of the Climate Colab is the shared attempt to contribute to solving the climate change problem, by realizing promising and impactful initiatives, in a collaborative way. Thanks to the direct and indirect network effects that allow the collection, convergence and integration of multiple competencies and expertise, the platform has the potential to become an opinion maker about topics, emerging approaches and promising solutions to face the problem of climate change. Moreover, by leveraging a globally distributed intelligence and the openness to collaborate, innovate and share resources, the platform realizes both efficiency gains in terms of cost and time, and effectiveness of proposals in terms goal achievement and impact of results. Finally, the possibility that members have to match-make with the most suitable

proposals (searching contests or navigating along multiple dimensions) ensures their active and motivated participation to the community itself. In such a way, members can receive back a sense of satisfaction, can enlarge their professional network, can develop new knowledge and competencies about climate change, and ultimately can obtain funds for implementing the initiatives they have created or supported.

5.5 "Governance" of the MIT Climate Colab

The governance structure of the Climate Colab is grounded on three main pillars. First, the terms of use of the platform state users' obligations and permissions, and copyright policy for material shared within the contests and during the online discussions. The second pillar is represented by the rules and guidelines for participating to a contest throughout its phases, from proposal submission to voting and awarding activities. Finally, the third pillar of the MSP governance is the community "philosophy" and principles that regulate activities, which are openness, honest broker, scientific evidence and rational argument, respect and courtesy, and value statement. These three pillars are codified into specific sections of the MSP web site (Figure 6).

Fig. 6: The pillars for the governance for the MIT Climate Colab



Source: www.climatecolab.org

A further non-official aspect of the governance is the certification of the impact of proposals that provides a measure of novelty, feasibility, impact, and presentation. This assessment is crucial since it determines if a proposal passes the evaluation phases within the contest. The fact that such certification is performed by domain experts and impact assessment fellows is a guarantee of the application of scientific approaches and rigorous techniques, in the final aim to maximize the value of the winning proposals for the interest of proponents and the society at large.

A possible evolution of the architecture of the Climate Colab is the adding of a new side. In particular, whereas sponsors and collaborators just support today the economic sustainability of the platform (by paying a fee) and the possible funding of proposals (by giving awards and prizes), they could evolve in the near future into a fourth side of the platform itself. In such a way, they can be directly involved into the teams and be engaged in the design and development of the proposals, by providing their technical expertise, market knowledge, intellectual assets, and entrepreneurial vision. This additional side of the platform would contribute to amplify both the direct and indirect network effects, thus increasing the overall impact of the initiative.

6. Discussions and Conclusion

Sustainability is a key-challenge of our times. Environmental pollution, climate change, sustainable mobility, social inequalities and poverty are examples of social problems that need to be faced globally. Institutions, policy makers and business organizations are key players in contrasting the daunting scenario and are today required to cooperate with the society in order to harness human initiative and energies in finding solutions for reaching sustainable development goals. The era of the digital economy, and technologies such as sharing platforms and collective intelligence systems, offer significant opportunities for supporting collaborative discourse and action to make sustainability principles fully internalized within organizations and societies. In such endeavor, this article has used a collective intelligence view to derive a conceptual framework of MSP as a value creation ecosystem able to support sustainable development policies and actions, and mediate transactions between groups of complementary and heterogeneous actors (Teece, 2018).

The article has discussed how next-generation innovation and business paradigms can drive a new way of designing and addressing solutions to big societal problems and support the definition of sustainable solutions. Actually, the adoption of the MSP model based on the collective intelligence paradigm allows for gathering distributed expertise and addressing them towards the definition of a set of valid proposals that can represent a possible solution for a wicked problem. Indeed, a typical feature of wicked problems is that they have not any single or definite computational formulation or a set of valid solutions, but only answers that are better or worse from different angles (Rittel and Webber, 1973).

The MSP may represent a valuable model to adopt for experimenting new configurations and solutions to contribute to solve societal problems. Indeed, beyond the successful applications of the MSP model into business-oriented contexts, this article is an attempt to apply the MSP logic and configuration into socially-relevant scenarios and sustainability-related challenges, where there is still limited evidence and experience. In such a view, by leveraging the logic of sharing and aggregating, as well as the direct and indirect network externalities (de Reuver *et al.*, 2018), the MSP has the potential to become an enabler of the business model innovation process at both industrial and organizational level (Grieco and Cerruti, 2018). This process implies a radical change of the mindset of organizations and societies, thus realizing three complementary paradigm shifts: from resource control to resource orchestration, from internal optimization to external interaction, from a customer-centered value to an ecosystem-centered value (Van Alstyne *et al.*, 2016).

The model defined and the application of the same to analyze the real case of the MIT Climate Colab has a number of implications at both theoretical and practitioner level. In terms of theory development, the article provides a new conceptual proposition about the relevance of multi-stakeholder and multi-disciplinary contribution for the collaborative identification of solutions to wicked social problems. More in detail, the multi-stakeholder and multi-disciplinary dimensions refer to the possibility to involve and engage, in an immediate and easy way, a huge number of field experts and domain-related professionals that may interact and collaborate on line to shape potentially effective solutions to the problem of climate change. These people are dispersed worldwide, have very different careers, diverse knowledge backgrounds and expertise, but share a common interest and are motivated by the same reason, which is to make a collaborative effort to contribute to solve the climate change problem. Moreover, the opportunity offered by the platform to get in touch with technical experts for the scientific validation of the proposals and the measurement of their climate change impact, as well as with potential investors and funders interest into the entrepreneurial exploitation of the results, contributes to enrich the multi-stakeholder and multi-disciplinary dimensions of the initiative, which represent a typical characteristic of a collective intelligence scenario. Moreover, the case of the MIT Climate Colab interpreted as a MSP based on collective intelligence may be considered as an example of Collective Creativity Platform (Iasevoli *et al.*, 2018), capable to aggregate into communities the people's skills, competencies and interests to ideate, design and build effective proposals for climate change.

The findings can thus drive new theoretical developments on the potential role of digital-enabled collaborative systems to streamline the definition of robust practices and initiatives aimed to improve sustainable development goals. Besides, by adopting a knowledge based perspective, the model of MSP defined could be adopted to analyze the dynamic and the intensity of knowledge flows within the community, by considering both the static dimension related to the availability of knowledge sources, and the dynamic dimension related to the evolution of the relationships among the individuals and between individuals and knowledge sources (Presenza *et al.*, 2018).

In terms of practitioner development, the article offers a management checklist and operational model useful to design purposeful strategies and projects in the area of sustainable development. Moreover, the implementation of the fourth side to the MIT Colab MSP through the involvement into the community of investors and entrepreneurs interested in the implementation and market exploitation of the most promising and impactful proposals, may contribute to transform the MIT Colab into an interesting case of digital entrepreneurship, where most of the phases of the entrepreneurial process are performed and supported by online services (Nambisan *et al.*, 2017).

Next research will be focused on applying the model to other real-life cases (e.g. OpenIdeo, MITSolve, GiveMeDrug) and come up with a refined framework of variables and components that could be used to assess the impact of the MSP by adopting performance metrics based on the intellectual capital.

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Modelli di business sostenibili orientati all'innovazione. Un'analisi esplorativa di un caso studio

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Abstract

Obiettivi: *La ricerca si propone l'obiettivo di migliorare la comprensione dei meccanismi attraverso cui alimentare la generazione di valore sostenibile. In particolare, assumendo come framework concettuale e come unità di analisi il modello di business lo studio mira a capire come la condotta strategica di un'impresa possa essere orientata verso la sostenibilità.*

Metodologia*: Lo studio adotta un approccio di ricerca orientato alla scoperta e privilegia, per la migliore comprensione del fenomeno indagato, l'analisi di un caso aziendale riferito ad un'azienda italiana che opera nel settore della moda dall'elevato potere esplicativo.*

Risultati*: Nel porre in risalto i driver per la creazione di innovazione orientata alla sostenibilità alla base del business model dell'azienda indagata, la ricerca propone un framework per la Sustainable Business Model Innovation (SBMI).*

Limiti della ricerca: *L'analisi di un singolo caso studio, per quanto esplicativo, non permette di giungere ad una generalizzazione dei risultati.*

Implicazioni*: Lo studio offre un contributo allo sviluppo delle teorie manageriali sull'innovazione con riferimento ai modelli di business orientati alla sostenibilità proponendo un framework interpretativo. Il caso analizzato rappresenta inoltre una best practice che potrebbe guidare manager e imprenditori a progettare già in fase di start up modelli di business sustainability driven.*

Originalità del lavoro: *In risposta ad un gap riscontrato nella letteratura, la proposta di studio è focalizzata sulle modalità attraverso cui le imprese dovrebbero incorporare a livello strategico e con una visione olistica la logica dello sviluppo sostenibile nei loro modelli di business.*

Parole chiave: *innovazione nei modelli di business sostenibili; business del fashion; strategie valoriali; creazione di valore sostenibile*

Objectives. *The research aims to better comprehend the mechanisms that allow the generation of sustainable value. In particular, assuming the business model as conceptual framework and as unit of analysis, the study aims to understand how the strategic conduct of a company can be oriented towards sustainability.*

Methodology. *The study adopts a research approach oriented to the discovery and it privileges the analysis of a business case with a high explanatory power.*

Findings. *In highlighting the drivers for the creation of sustainability-oriented innovation at the base of the analysed company business model, the research proposes a framework for the Sustainable Business Model Innovation (SBMI).*

Research limits. *The analysis of a single case study, although explanatory, does not allow to reach a generalization of the results.*

Practical implications. *The study offers a contribution to the development of managerial theories on innovation with reference to business models oriented to sustainability. The case analyzed is also a best practice that could guide managers and entrepreneurs to plan sustainability-driven business models already in the start-up phase.*

Originality of the study. *In response to a gap in the literature, the study proposal is focused on how companies should incorporate the logic of sustainable development into their business models at a strategic and holistic level.*

Key words*: sustainable business model innovation; fashion business; value strategies; creation of value*

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1. Introduzione

La sostenibilità si caratterizza per una natura multiforme, che rende arduo giungere ad una definizione univoca del concetto (Ciasullo, 2010; Metcalf e Benn, 2013). La prima significativa tappa per l'avvio del dibattito scientifico è da rinvenirsi nel rapporto Brundtland in cui lo sviluppo sostenibile è definito quale sviluppo economico teso a soddisfare "*i bisogni del presente senza compromettere la capacità delle generazioni future di soddisfare i propri bisogni*" (WCED, 1987, p. 43). Da tale ottica svariate interpretazioni si sono avvicendate, tutte accomunate dalla necessità di preservare le risorse o almeno di usarle con parsimonia.

Un'importante concettualizzazione è costituita dal modello *The Triple Bottom Line* (TBL) o delle "Tre P" (Profitto, Persone, Pianeta) (Elkington, 1997; 2006) che identifica le tre dimensioni costitutive di natura economica, sociale e ambientale alla base dello sviluppo sostenibile. Nel presente lavoro, il TBL viene assunto come la più completa concettualizzazione in quanto la sua triplice dimensione è alla base della creazione di valore integrato (Elkington e Hartigan, 2008).

In tale prospettiva, affinché la dimensione sociale ed ambientale della sostenibilità siano integrate alla logica di business è fondamentale che l'impresa orienti la sua condotta attraverso innovativi business model (Pencarelli et al., 2019).

Nell'ultimo decennio, infatti, la letteratura manageriale è sempre più concorde nel ritenere che le possibilità di incrementare il successo di mercato dipendano dalla capacità di generare innovazioni orientate alla sostenibilità (*Sustainability-Oriented Innovation*, SOI), legate all'introduzione di nuovi o migliorati prodotti/servizi, processi organizzativi, pratiche aziendali attraverso cui prevenire o ridurre gli impatti negativi sull'ambiente e sulla società (Schaltegger e Wagner, 2011).

Sebbene dal punto di vista teorico siano stati delineati possibili archetipi di modelli di business orientati alla sostenibilità, ciò che traspare dall'analisi della letteratura è tanto la mancanza di una visione olistica, in ragione di uno sbilanciamento verso la dimensione sociale e della Corporate Social Responsibility, quanto l'assunzione di una visione riduzionista in cui si analizzano empiricamente le relazioni tra obiettivi di sostenibilità e prestazioni aziendali (Wood, 2010; Glavas e Mish, 2015) secondo una prospettiva di tipo quantitativo.

Sulla base del *gap* riscontrato in letteratura, obiettivo della ricerca è migliorare la comprensione dei meccanismi attraverso cui alimentare la generazione di valore sostenibile, adottando un approccio qualitativo ed assumendo come framework concettuale e come unità di analisi il modello di business (Zott et al., 2011).

Tali riflessioni teoriche sono approfondite con riferimento al *fashion*, un settore critico dal punto di vista della sostenibilità dal lato sia della domanda che dell'offerta (Fletcher e Grose, 2012; Ciasullo et al., 2017a), in cui la necessità/opportunità per le imprese di adottare modelli di business innovativi risulta ancora più urgente (Beh et al., 2016; Lueg et al., 2015).

Pertanto, le domande cui ci si propone di rispondere sono:

RQ1- *Quali sono i principali driver per la creazione di innovazione orientata alla sostenibilità nei business model sostenibili?*

RQ2- *Come può essere gestito il processo di generazione, creazione e cattura del valore?*

Nel complesso, il lavoro contribuisce allo sviluppo di un framework che potrebbe guidare manager e imprenditori a progettare già in fase di start-up modelli di business sustainability driven. Il paper è strutturato come segue. Innanzitutto, viene proposta una *review* della letteratura in relazione ai temi dell'innovazione orientata alla sostenibilità e sul ruolo dei modelli di *business* per la creazione di valore integrato. Segue l'illustrazione della metodologia della ricerca seguita nel condurre un'indagine esplorativa di natura qualitativa. Vengono pertanto analizzati e discussi i risultati per poi evidenziare le implicazioni teorico-manageriali.

2. Analisi della letteratura

2.1 L'innovazione orientata alla sostenibilità

Al fine di rileggere l'innovazione secondo i canoni della sostenibilità, i valori dell'organizzazione, così come le pratiche ed i processi aziendali anche quando riferiti al mercato, dovrebbero essere orientati alla creazione di valore sociale, ambientale ed economico. In questa direzione, l'orientamento alla sostenibilità viene concettualizzato quale capacità dinamica (o *meta-capability*) tesa a supportare l'impresa in un processo di co-evoluzione (Leonidou *et al.*, 2015; Peters *et al.*, 2011) rispetto ai diversi ecosistemi di cui è parte integrante.

Affinché la sostenibilità sia integrata nelle strategie d'impresa e si traduca in azioni concrete orientate ad uno sviluppo sostenibile sono richiesti profondi cambiamenti in termini di comportamenti, cultura, interessi, enfatizzando così la rilevanza della componente umana. D'altro canto, gli attuali mercati sempre più competitivi sfidano le imprese non solo a ricercare continue soluzioni innovative nelle proposte di valore realizzate, ma anche a innovarle sul fronte della sostenibilità ambientale, sociale, oltre che economica. Basti pensare, infatti, che il comportamento d'acquisto dei consumatori è sempre più condizionato dalla volontà di soddisfare i propri bisogni ponendo una crescente attenzione e sensibilità ad aspetti sociali ed ambientali (Kuckertz e Wagner, 2010). Ciò si traduce nella scelta di acquistare prodotti sostenibili perché ritenuti di maggiore qualità (ad esempio in termini di salubrità, tracciabilità, estetica, ecc.) oltre che rispettosi dell'ambiente (Da Giau *et al.*, 2016). La preferenza per i prodotti percepiti come sostenibili, infatti, rende i consumatori disposti non solo a riconoscere un *premium price* ma ad innalzare il loro *engagement* e la loro disposizione collaborativa (Ciasullo *et al.*, 2017b). In sintesi, i mercati postulano un crescente approccio valoriale rispetto ad aspetti meramente funzionali ed edonistici superando in tal modo una visione statica e dicotomica della sostenibilità che poco si adatta all'innovazione quale processo in divenire, orientato ad una logica di crescita di lungo termine ed in cui la dimensione sociale ed ambientale della sostenibilità sono sinergicamente integrate alla logica di *business* dell'impresa (Ciasullo e Troisi, 2013; Barile *et al.*, 2015).

Per intraprendere un percorso orientato alla sostenibilità dinamicamente intesa, si delinea l'urgenza di innovativi modelli di *business* basati su peculiari posture organizzative capaci di guidare le imprese ad innovare in chiave sostenibile (Dubey *et al.*, 2017). In tale direzione, si richiede una trasformazione del *modus operandi* dell'impresa orientato a creare valore condiviso (Porter e Kramer, 2011) a vantaggio non solo dell'impresa stessa, ma di clienti, fornitori, *partner*, istituzioni e società in generale realizzando il "*good by doing new things*" (Adams *et al.*, 2016, p. 190). Tale trasformazione richiede un decisivo *shift* di mentalità verso l'integrazione della sostenibilità nella cultura aziendale in una logica che si sposti da un *focus* interno ad uno esterno guidato da un approccio collaborativo e supportato da reti di relazioni grazie alle quali "*doing good by doing new things with others*" (Adams *et al.*, 2016, p. 192) che assumono la forma di innovazioni di prodotto, di processo o di pratiche di *business.* In tale visione relazionale e sistemica l'innovazione è ridefinita come esito di articolati processi che, travalicando i confini aziendali, sono basati sulle interazioni e sugli sforzi di molteplici attori estendendosi anche agli utilizzatori finali in una logica di co-creazione di valore multi attore e multi *stakeholder* (Vargo e Lusch, 2011).

2.2 Modelli di business innovativi orientati alla sostenibilità: verso la creazione del valore sostenibile

2.2.1 Business model e business model innovation

Strumento di sintesi, analisi e valutazione delle strategie e dei processi aziendali, il *business model* può essere assunto quale *framework* concettuale per identificare le modalità attraverso cui creare e catturare valore (Teece, 2010; Zott *et al.*, 2011). In particolare, i modelli di business contribuiscono a qualificare il contenuto (risorse, capacità, informazioni), la struttura (relazioni e

interazioni tra le parti che condividono risorse) e il ruolo del management strategico (deputato a gestire contenuto e struttura) allo scopo di creare valore sociale e ambientale sfruttando le opportunità di *business*.

In chiave strategica, il *business model* è inteso quale insieme di strumenti che, su base ciclica, supportano il controllo del *fit* tra la configurazione d'impresa e le strategie implementate (Richardson, 2008) in una prospettiva reticolare che considera le relazioni come principali fattori abilitanti della creazione e co-creazione del valore (Prahalad e Ramaswamy, 2000) e la cui irripetibilità e unicità sono fattori critici che predispongono all'innovazione (Pencarelli et al., 2019).

La considerazione dei *business model* come esito di un complesso processo volto a definire gli assetti più idonei perché sia favorito lo sviluppo di processi innovativi, in un'era di complessità, conduce all'introduzione della *Business Model Innovation* (BMI, Labbé e Mazet, 2005; Lindgardt *et al.*, 2009) che segna il passaggio verso la concettualizzazione e l'implementazione di *business model* non più staticamente intesi, incentrati sullo studio del "modo in cui" si fa impresa e non più sul semplice contenuto delle strategie e condotte aziendali (Amit e Zott, 2012).

Dalla combinazione dei fattori chiave dei *business model* e degli antecedenti dell'innovazione, Chesbrough (2010) identifica il BMI come risultato di una serie di *step* in cui le imprese: 1) articolano la propria *value proposition*; 2) identificano un segmento di mercato; 3) definiscono la *value chain* più adatta per distribuire l'offerta; 3) stimano i costi e i potenziali profitti; 4) identificano il *network* di stakeholder più adeguato.

Inoltre, a partire dalla proposta di una visione di processo *value-oriented* allo studio dei business model innovativi, Osterwalder (2004) introduce il modello Canvas identificando le seguenti fasi: 1) design; 2) definizione della value proposition; 3) sviluppo dello schema del business model; 4) assessment strategico; 5) innovazione del modello di business.

2.2.2 Dai business model sostenibili ai sustainable business model innovation: fattori chiave

Con la crescente diffusione del concetto di sostenibilità all'interno degli studi aziendali (Carroll, 1999; Elkington, 1997), la vera sfida per la definizione dei *business model* in ottica integrata nasce dalla necessità di dover inglobare al solo valore economico o relazionale i molteplici interessi di una società sempre più esigente, che domanda alle imprese di soddisfare richieste economiche quanto sociali, ambientali ma legate soprattutto allo sviluppo di benefici che siano orientati alla crescita della collettività.

Un *business model* sostenibile (*sustainable business model*, SBM, Nidumolu *et al.*, 2009; Bocken *et al.*, 2014) richiede di essere realizzato mediante il perseguimento simultaneo della competitività e del successo economico e socio-ambientale (Schaltegger *et al.*, 2016). Tuttavia, le ricerche concettuali ed empiriche sul tema non offrono risposta a come un modello di *business* possa sviluppare l'innovazione orientata alla sostenibilità (Schaltegger e Wagner, 2011; Stubbs e Cocklin, 2008), evidenziando, al contrario, una certa ambiguità sulla duplice natura della sostenibilità intesa, da un lato, come *driver* per l'innovazione e, dall'altro, come fattore da incapsulare a monte delle strategie di generazione dell'innovazione (Schaltegger *et al.*, 2016).

Alcuni studiosi accolgono la sfida dell'integrazione dei tradizionali *driver* dei *business model* per il successo aziendale all'interno di una vera e propria strategia sostenibile che ripensa l'intero profilo strategico aziendale (Hansen 2010; Stead e Stead, 2008; Wagner, 2007).

Nello specifico, Stubbs e Cocklin (2008) propongono l'introduzione di un approccio sistemico per la qualificazione dei *business model* sostenibili, che medi tra: 1) attributi strutturali: struttura organizzativa, processi, pratiche e *policy* organizzative mirate all'ottenimento di *outcome* sostenibili; 2) attributi culturali: norme, valori, comportamenti, atteggiamenti che innalzino l'engagement degli stakeholder.

Particolare enfasi assume la rilevanza della dimensione umana e culturale: i *leader* sostenibili sono coloro che abilmente sono capaci di incapsulare i principi della sostenibilità nella cultura organizzativa istituzionalizzando un insieme coeso di relativi valori nella mente degli *stakeholder* chiave (Bansal, 2002).

Adottando una visione d'insieme, Bocken *et al.,* (2014) intendono i *business model* sostenibili come frutto dell'adozione di una strategia imperniata sul perseguimento della TBL e mirati all'inclusione di un variegato *set* di *stakeholder*, portatori dei più svariati interessi economico-sociali. Secondo gli autori, l'inclusione strategica della sostenibilità all'interno dei modelli aziendali può agire da *driver* per il vantaggio competitivo e lo sviluppo di innovazione (Yip e Bocken, 2018).

Schaltegger *et al.,* (2016) pongono la necessità di ridefinire il *design* del *business model* creando in tal modo un raccordo tra la strategia sostenibile progettata e le pratiche e i processi innovativi realmente implementati. Il modello mira a intercettare i fattori leva su cui imperniare la proposizione e la diffusione del valore. Assecondando tale ragionamento, non è sufficiente implementare attività eco-sostenibili ma vi è l'urgenza di sviluppare un comportamento manageriale proattivo e flessibile, teso ad affrontare e gestire i rischi in modo dinamico e far leva sulle competenze acquisite e su di un'efficiente gestione dell'informazione per accrescere il valore. Si introducono, quindi, le dimensioni critiche dell'allocazione e dello scambio di risorse ottimali e della gestione delle conoscenze e dell'informazione.

In una concezione del *business model* come schema che sintetizzi un insieme di processi multi-stakeholder e orientati alla creazione di valore nel lungo termine, Geissdoerfer *et al.,* (2018) concettualizzano il *Sustainable business model innovation* (*SBMI*) quale adattamento del *business model* alla TBL tramite l'implementazione dei principi di *management* proattivo tesi a stimolare la creazione e diffusione di conoscenza e nuovo valore (Boons e Ludeke-Freund, 2013; Bocken *et al.,* 2014; Geissdoerfer *et al.,* 2016; Schaltegger *et al.,* 2016). In realtà, una simile rilettura di stampo *sustainable value-based* si rifà alle concettualizzazioni proposte da Richardson (2008) e Amit e Zott (2010) all'interno del filone *resource-based* e di quello strategico, ma le adatta ai canoni della sostenibilità. Se il *core* del processo rappresentato e pianificato dai *business model* è il valore, sono tre i momenti chiave della sua propagazione: 1) la proposizione, 2) la creazione-*delivery* ("consegna" o scambio, rilascio); 3) la cattura. I *business model* sostenibili vengono così reinterpretati come rappresentazioni semplificate e descrittive della logica organizzativa atta a favorire i processi di proposizione, creazione e cattura del valore, nonché le relazioni tra questi elementi (Geissdoerfer *et al.,* 2018).

Nonostante l'adozione di svariati approcci, ciascuno teso a enfatizzare un singolo aspetto del problema, sembra non emergere una concettualizzazione delle categorie di analisi generale (Bocken *et al.,* 2014) che orientino i *business model* sostenibili. Tali dimensioni critiche potrebbero confluire all'interno di un *framework* generale a cui ricondurre empiricamente e di volta in volta le pratiche legate all'implementazione dei modelli di business.

Ed è proprio in nome di tale esigenza di categorizzazione che il presente lavoro, ponendosi in continuità con lo studio intrapreso da Geissdoerfer *et al.,* (2018), mira a proporre una rilettura dei *business model* "classici" in base ai principi della sostenibilità per definire i driver della creazione e co-creazione di valore e di innovazione sostenibile.

Dunque, a partire dalla concezione della sostenibilità intesa come componente strategica da amalgamare sinergicamente a monte dei modelli di *business*, in qualità di *driving force* e non di "mero" *outcome* dei processi aziendali, in una visione *process-based* la creazione di nuovo valore, dunque di innovazione sostenibile, viene qualificata quale esito di meccanismi dinamici e circolari di generazione e diffusione di valore.

L'integrazione dell'approccio *value-based* con i principi della *sustainable business model innovation* viene effettuata attraverso la proposta di una visione di sintesi. In ottica ciclica, la generazione, la diffusione e la co-creazione di nuovo valore sono visti come processi da gestire tramite "apposite" strategie di co-creazione per dare vita a innovativi *outcome* sociali, economici e ambientali che possano puntare allo sviluppo e alla crescita sostenibile proprio perché scientemente supportati ed allineati da una cultura organizzativa sostenibile.

In una prospettiva mirata a valorizzare la componente umana (*skill* interne ed esterne all'organizzazione, abilità relazionali, competenze manageriali e leadership proattiva) nel processo di diffusione di tale cultura si concepisce come *step* preliminare di un business realmente sostenibile l'incorporazione dei principi della sostenibilità nelle strategie e nei *core value* aziendali. Tale

cultura necessita di essere costantemente rinnovata dando vita ad un valore unico e dunque inimitabile, derivante dalla sinergia irripetibile determinata dagli scambi di risorse tra i molteplici *stakeholder* che condividono abilità, esperienza, creatività, stimolando innovazione continua e di lungo termine e dunque sostenibile (Sciarelli e Tani, 2015).

All'interno della prospettiva abbracciata in questo lavoro, si propongono in Tabella 1 le principali dimensioni atte a supportare l'emersione del valore nei *sustainable business model innovation* discussi in letteratura. Tali variabili costituiscono i *topic* di riferimento per la stesura della traccia dell'intervista e la successiva analisi dei dati (si veda il paragrafo 3) relativi all'indagine empirica.

Tab. 1: Sintesi delle principali dimensioni del Sustainable Business Model innovation e relative strategie valoriali

Dimensioni	**Strategie valoriali**	**Fonti**
STRATEGIA	**PROPOSIZIONE** di valore	Geissdoerfer *et al.* (2018); Bocken *et al.*, (2014); Amit e Zott, (2012); Chesbrough (2010)
CULTURA	**DIFFUSIONE** di una cultura proattiva e orientata alla sostenibilità	Geissdoerfer *et al*. (2016); Schaltegger e*t al*. (2016); Bocken *et al*., (2014); Boons e Ludeke-Freund (2013)
RISORSE	**SCAMBIO** e **COMBINAZIONE** di valore	Geissdoerfer et al. (2018); Sciarelli e Tani (2015)
PARTNERSHIP	**CREAZIONE E CO-CREAZIONE** di valore sociale, ambientale, economico	Schaltegger *et al.* (2016); Bocken *et al.* (2014); Stubbs e Cocklin (2008)
LEADERSHIP	Armonizzazione degli scambi e potenziale **RINNOVAMENTO** del valore	Yip e Bocken (2018); Geissdoerfer *et al.*, (2018); Bocken *et al.*, (2014); Bansal (2002)

Fonte: ns. elaborazione

Nello specifico, sulla base della *review* della letteratura condotta e in nome dell'approccio di sintesi che si mira a introdurre le dimensioni (considerate come *driver*) che agiscono da elementi propulsori del cambiamento sociale e dell'innovazione orientata alla sostenibilità sono: 1) strategia; 2) cultura; 3) risorse; 4) *partnership*; 5) *leadership*. L'approccio di sintesi propone innanzitutto che gli obiettivi sostenibili siano inclusi nelle strategie complessive aziendali, in modo da allineare a queste ultime i processi e le tattiche realmente implementati (Rosemann e Von Brocke, 2010). L'accrescimento del *fit* tra strategia e tattica può essere perseguito grazie alla creazione di una cultura coesa che attiva uno scambio di risorse tra attori consonanti e dotati di capacità e competenze complementari le quali, opportunamente e dinamicamente combinate, possono generare nuovo valore sostenibile. L'intero processo si mostra circolare poiché il nuovo valore realizzato si istituzionalizza, divenendo nel tempo conoscenza condivisa la quale, a sua volta, alimenta e reintegra i successivi scambi. In tale processo, un indispensabile fattore critico di successo è rivestito dai soggetti decisori e manageriali i quali dovrebbero gestire e armonizzare le anzidette dinamiche.

3. Metodologia della ricerca

Con l'obiettivo di indagare i meccanismi ed i fattori abilitanti la creazione di valore sostenibile, lo studio adotta un approccio esplorativo. In riferimento alla prima domanda di ricerca (RQ1), in particolare, lo scopo è cogliere quali siano i fattori critici (in termini di strategie, cultura e capacità organizzative, risorse, risorse umane e *leadership*) necessari a supportare un modello di *business* orientato alla sostenibilità e alla produzione di innovazione sostenibile. Parallelamente, per rispondere alla seconda domanda di ricerca (RQ2), si intende ricostruire il processo di creazione, diffusione, creazione e co-creazione di nuovo valore che si ipotizza possa intersecarsi alle varie aree creando potenzialmente un ciclo di *sustainable value creation*.

Nello specifico, è stato adottato un approccio di ricerca orientato alla scoperta (Wells, 1993), che privilegia un'analisi di tipo qualitativo allo scopo di giungere ad una migliore comprensione del

fenomeno indagato. A tal fine, si è optato per la metodologia del caso studio, che consente di investigare il come e il perché di un fenomeno contemporaneo nel suo contesto naturale, soprattutto quando i confini tra fenomeno e contesto non sono chiaramente distinguibili (Yin, 2015).

Il caso di studio ha per oggetto "Progetto Quid", azienda italiana che opera nel settore della moda femminile e che rappresenta una realtà capace di coniugare innovazione, sostenibilità e tecnologia digitale. Ciò è testimoniato dalla *Mission* aziendale: "Unire il bello del *fashion* con la moda etica: partire dalle eccedenze di produzioni tessili per arrivare alla creazione di valore sociale"; dai continui investimenti in attività di R&S; da uno spiccato orientamento alla sostenibilità sociale, ambientale, economica. Per gli anzidetti motivi, Progetto Quid rappresenta un eccellente contesto empirico in cui affrontare le domande di ricerca alla base del lavoro.

3.1 Raccolta e analisi dei dati

La raccolta dei dati, realizzata nel periodo tra dicembre 2018 e febbraio 2019, ha previsto la conduzione di una serie di interviste in profondità, in cui gli intervistati hanno determinato ciò che era rilevante in relazione all'obiettivo di ricerca (Alvesson, 2003). Le interviste hanno coinvolto manager e dipendenti operanti nelle seguenti aree aziendali: R&S, risorse umane, *digital* e comunicazione, *marketing*, relazioni istituzionali. Il criterio di selezione è da individuarsi nella capacità esplicativa degli intervistati di rappresentare in modo olistico i processi alla base del modello di *business*. Le interviste *face-to-face*, condotte presso la sede aziendale per una durata di circa 50 minuti ognuna, sono state poste in domande aperte ad un totale di 10 soggetti.

In linea con le domande di ricerca (Par. 1) e con le dimensioni critiche dei *business model* sostenibili orientati all'innovazione innanzi identificate (Tabella 1), è stata predisposta la traccia dell'intervista (riportata in Appendice) e articolata nei seguenti *topic*:

1. informazioni generali sull'Azienda;
2. dimensione "strategia": principi e valori chiave e loro proposizione/diffusione;
3. dimensione "cultura": inglobamento dei valori sostenibili nella cultura aziendale;
4. dimensione "risorse": principali risorse scambiate e tecnologie impiegate nella creazione di valore sostenibile;
5. dimensione *"partnership"*: principali partnership e collaborazioni attivate e valorizzazione di risorse umane e competenze;
6. dimensione "*leadership*": capacità manageriali e decisionali chiave per la gestione dei processi di creazione del valore e per lo sviluppo dell'innovazione sostenibile;
7. dimensione "sviluppo dell'innovazione sostenibile": visione dell'innovazione, *outcome* perseguiti e strategie per il rinnovamento dell'innovazione sostenibile.

Per il reperimento di dati più specifici, in particolare riferiti al punto 1, l'analisi dei dati primari è stata corredata da un'analisi di dati secondari derivati dal sito web ufficiale e da specifici documenti aziendali (Tabella 2). Inoltre, quale driver per l'innovazione sostenibile, rispetto alle dimensioni ricavate dalla *review* critica della letteratura, è stata introdotta la dimensione (punto 7) dell'innovazione sostenibile intesa come *outcome* dell'intero processo abilitato dagli antecedenti relativi alle prime cinque dimensioni evidenziate. Se è vero che le strategie di innovazione sostenibile sono deducibili dall'analisi degli altri temi-variabili, è risultato opportuno creare delle domande-guida specifiche sull'argomento, per rilevare quanto l'innovazione sostenibile potesse essere strategicamente ricercata e protratta nel tempo.

La traccia rappresenta dunque una lista di macro-aree da trattare nel corso dell'intervista (Bichi, 2002) in maniera flessibile, rispettando le inclinazioni personali e il profilo dei soggetti indagati, facendo sì che i temi prefissati emergano in maniera quanto più spontanea possibile dalle parole dell'intervistato. In tal modo, si mira a ridurre al minimo l'intervento dell'intervistatore che svolge un ruolo per lo più strategico-interpretativo incentrato sull'ascolto e ad evitare dunque potenziali forme di distorsione.

In merito all'analisi dei dati, un passaggio preliminare è stato quello di definire un protocollo di ricerca attraverso cui organizzare ed interpretare i dati via via ottenuti e classificati poi in categorie

omogenee aumentando in tal modo l'affidabilità della ricerca (Yin, 2015). Il processo di codifica, di tipo iterativo, si è basato sulla classificazione, test e ridefinizione dei dati raccolti.

4. I risultati

I risultati dell'analisi condotta sono stati classificati in base alla suddivisione nei principali *driver* dei *business model* per l'innovazione sostenibile identificati nel paragrafo 2 ed adottati come linee guida per la stesura della traccia dell'intervista.

Pertanto, nei successivi sotto-paragrafi, sono riportati per ciascuna delle diverse variabili dell'intervista: 1) i fattori chiave del *business model* sostenibile orientato all'innovazione di Quid (RQ1), le relative strategie e i principali *outcome* per lo sviluppo dell'innovazione; 2) le strategie per la creazione di valore sostenibile (RQ2), che ci si aspetta avvenire trasversalmente alle differenti dimensioni di *business*.

4.1 Panoramica dell'azienda: principali attività e rete commerciale

Il progetto Quid nasce nel 2012 a Verona come associazione di promozione sociale, per volontà di cinque giovani amici, appassionati di moda e molto sensibili verso le tematiche sociali, che hanno scelto di investire il loro tempo e le loro competenze per abbracciare la grande sfida di dare vita ad un progetto di moda etica che coniuga moda, solidarietà e sostenibilità.

Stando alle parole di uno dei responsabili del marketing: "*Quid, come sottolinea l'etimologia stessa del termine, mira ad offrire qualcosa in più, sia in termini di unicità che di contributo alla risoluzione di alcune urgenti tematiche sociali che oggi, nel 2019, non sono ancora del tutto risolte, come la tutela e la crescita economica delle fasce di popolazione svantaggiate, l'offerta di condizioni lavorative egualitarie alle donne e la valorizzazione delle diversità culturali*".

Le affermazioni fanno emergere la volontà di perseguire obiettivi economico-sociali già a partire dalla visione oltre che dalla missione dell'azienda. In effetti, Quid può essere letto anche come un acronimo, come evidenzia un altro marketing manager: "*Q significa qualcosa in più, 'U' ha a che fare con l'unicità, 'I' con l'innovazione, 'D' è riferito invece ad uno dei nostri interlocutori principali: le donne"*.

I principi sostenibili (prevalentemente di natura sociale ed economica) sembrano essere strettamente connaturati alla ricerca dell'innovazione, come conferma uno dei prioritari obiettivi dell'impresa: *creare un valore aggiunto per la comunità, i clienti, i partner, con una spiccata sensibilità verso i problemi sociali e ambientali"*.

Com'è possibile notare in Tabella 2, ottenuta dall'incrocio delle interviste e dalla raccolta di dati secondari (Par. 3), l'Azienda si è sviluppata tanto in termini di capacità produttiva e di *performance*, quanto in termini di *network* relazionale.

A partire dall'apertura del primo *temporary store* nell'estate del 2014, QUID ha maturato un percorso di crescita costante contraddistinto da un aumento annuo del fatturato e del personale impiegato registrando nel 2018 un fatturato di circa 3 milioni di euro e un numero di dipendenti pari a 114. Per ciò che concerne la rete di vendita, l'azienda distribuisce i propri capi attraverso un centinaio di punti vendita multi-brand in Italia, 5 negozi monomarca (due a Verona, uno a Mestre, uno a Bassano del Grappa e uno a Bologna), 2 *outlet* e *online* sull'e-commerce progettoquid.it/e-shop/; inoltre QUID collabora stabilmente con marchi di moda e *life style* di rilevanza internazionale per la creazione di linee dedicate di accessori etici.

Tab. 2: Trend di sviluppo di Progetto Quid nel periodo 2013-2018

	2018	**2017**	**2016**	**2015**	**2014**	**2013**
Fatturato	€ 2.800.000 €	€ 1.943.320	€ 1.054.183	€ 492.973	€ 290.000	€ 90.000
Personale	114	88	60	17	5	2
- donne	80%	80,88%	55,56%	90,9%	80%	50%
- età	19-67 anni	19-67 anni	18-65 anni	27-61 anni	26-55 anni	25-31 anni
- nazionalità	15 paesi	13 paesi	11 paesi	3 paesi	Italiana	Italiana
Clienti B2B	10	10	8	4	3	2
Fornitori	40	17	7	ND	ND	ND
Sito produttivo	Ristrutturazione del nuovo sito produttivo ad Avesa (Verona). Apertura di un laboratorio sartoriale nella sezione maschile del carcere di Verona e mantenimento di quello già attivo nella sezione femminile del carcere di Verona	Apertura di un nuovo sito produttivo ad Avesa (Verona) da ristrutturare. Mantenimento attività laboratorio sartoriale nella sezione femminile del carcere di Verona	Mantenimento operatività nello spazio produttivo ad Avesa (Verona) e mantenimento attività laboratorio sartoriale nella sezione femminile del carcere di Verona	Apertura di un nuovo spazio produttivo ad Avesa (Verona). Apertura laboratorio sartoriale nella sezione femminile del carcere di Verona	Apertura del primo laboratorio diretto	Esternalizzazione produzione a 3 cooperative locali
Rete commerciale						
- nr. punti vendita monomarca	5 store stabili (Verona, Mestre, Bassano del Grappa, Bologna)	Apertura di un negozio stabile nella provincia di Mestre (in totale n. 5 store)	Apertura di un negozio stabile a Verona, nel centro storico (in totale n. 5 store nel Veneto)	1 store stabile	Inaugurazione di due temporary store (a Forte dei Marmi e a Verona)	-
- nr. punti vendita multibrand	100 in Italia	60-70	ND	ND	ND	ND
- nr. outlet	Sono operativi due outlet (a Vallese e Cadriano)	Apertura di un outlet (a Cadriano e Bassano del Grappa)	Apertura di un outlet nella provincia di Verona, uno a Cadriano, uno a Bassano del Grappa	-	-	-
- e-commerce	si	si	Si	si	si	-
Rete solidale: realtà di assistenza, accoglienza e recupero	13	12	ND	ND	ND	ND

Fonte: ns. elaborazione

4.2 Strategia

Come evidenziato dai risultati emersi nella sezione precedente, alla base della ragion d'essere di Quid vi è un'innata attenzione verso le tematiche sostenibili, con un particolare interesse verso sfide sociali quali: inclusione sociale, sviluppo socio-economico delle fasce di popolazione svantaggiate e valorizzazione del ruolo femminile all'interno della società tramite il miglioramento delle condizioni lavorative. Dunque, la sostenibilità è imperniata a monte delle strategie aziendali, che si sostanziano nella preliminare creazione di un *set* di *core value* mirato a diffondere nel lungo termine una cultura orientata all'innovazione sostenibile.

In merito alla tutela del lavoro femminile, il responsabile relazioni istituzionali sottolinea tra i valori chiave di Quid la promozione del "*reinserimento lavorativo di persone in condizioni di difficoltà, soprattutto donne, attraverso il loro impiego in attività produttive che rispondono alle logiche del mercato e che stimolano una partecipazione attiva alla bellezza e alla creatività*". Dunque, l'impresa è impegnata nella valorizzazione di personale, in primis figure femminili che siano espressione di affidabilità e sensibilità. Unendo responsabilità sociale, ambientale e di mercato, Progetto Quid porta valore sul mercato, "*offrendo a persone in stato di fragilità*

un'occasione lavorativa tramite la creazione di capi di abbigliamento e accessori".

La proiezione dello sguardo aziendale verso il futuro è sostenuta da una leadership proattiva nella ricerca costante del miglioramento e del cambiamento sociale e del *fit* tra le strategie sostenibili progettate e le tattiche e i processi operativi realmente implementati.

La pianificazione strategica di momenti di confronto continuo su idee, opportunità, proposte, criticità, esigenze, *feedback*, sviluppa un pensiero e un impegno collettivo più efficiente ed efficace e contribuisce alla diffusione di una cultura sostenibile e al radicamento della vision aziendale all'interno della comunità: "*il nostro prodotto riesce a stare sul mercato. Quando il cliente viene informato sulla finalità che ci sta dietro compra ancora più volentieri. Vogliamo che il nostro cliente sia attratto dalla bellezza e dalla unicità del nostro prodotto, per caricare il nostro prodotto anche del valore etico, sociale e ambientale che ha dietro*". La Tabella 3 riassume i principali risultati ottenuti in merito alla variabile strategica.

Tab. 3: Principali risultati per la dimensione "strategia"

Principali driver (RQ1)	**Strategie di gestione dei driver**	**Strategie di gestione della creazione di valore sostenibile (RQ2)**	**Principali outcome per lo sviluppo dell'innovazione**
Orientamento sostenibile	Creazione di un set di valori coeso da diffondere presso gli stakeholder basati su: - Inclusione sociale - Unicità - Valore etico - Perseguimento di sfide sociali e di rilancio economico	Progettazione di una Value proposition sostenibile	Accoglimento di sfide sociali quali: - Inclusione sociale - Tutela segmenti svantaggiati - Sviluppo occupazione femminile - Creazione di valore aggiunto per la comunità
Leadership (innovativa-proattiva)	Rafforzamento della condivisione della vision (engagement interno)	Anticipazione dei cambiamenti ambientali	Cambiamento sociale Creatività
Pianificazione strategica di momenti di condivisione	Traduzione della vision in termini operativi	Processi di allineamento emergente della strategia sostenibile aziendale con: - Le tattiche realmente implementate; - I valori etici- individuali dei consumatori.	*Fit* e *cultural alignment*

Fonte: ns. elaborazione

4.3 Cultura

Se la strategia incorpora la progettazione di un *set* di valori fondati sulla sostenibilità e sull'innovazione, la diffusione (intra e inter-organizzativa) di tali valori è tesa alla creazione di una cultura coesa che accomuni e innalzi il senso di appartenenza della totalità degli stakeholder. Si rileva infatti una visione condivisa tra i membri aziendali, i consumatori, la comunità tutta, in merito alla necessità di risolvere complesse tematiche economiche, sociali e ambientali sostenibili.

Tra le attività volte a diffondere i valori chiave della cultura sostenibile, si annoverano specifici progetti sociali promossi e sostenuti attraverso un'intensa attività di raccolta fondi mediante la partecipazione a bandi, concorsi, premi internazionale aventi come tematica l'innovazione sociale e a bandi, concorsi, premi locali aventi come tematica la valorizzazione del territorio. Tale fattivo impegno consente all'impresa di sostenere l'offerta di servizi di supporto all'inserimento lavorativo, creando un vero e proprio sistema di *welfare* nel cui ambito è stata anche prevista la creazione di un percorso di alfabetizzazione digitale del personale aziendale.

La spinta innovativa verso la proposta di un nuovo sistema di *welfare* (da un punto di vista socio-politico) è supportata, sotto un profilo più strettamente culturale, dalla creazione di nuove norme sociali, comportamenti o stili di vita (Tabella 4).

Tab. 4: Principali risultati per la dimensione "cultura"

Principali driver (RQ1)	**Strategie di gestione dei driver**	**Strategie di gestione della creazione di valore sostenibile (RQ2)**	**Principali outcome per lo sviluppo dell'innovazione**
Cultura collettiva sostenibile	Fornitura di servizi di promozione e di marketing di valori condivisi	Diffusione di una cultura coesa basata su valori sostenibili condivisi	Sensibilizzazione verso le tematiche sociali, di sviluppo economico e ambientale
Sviluppo di progetti sociali	Attività di raccolta fondi mediante la partecipazione a bandi, concorsi, premi	Pianificazione strategica di momenti di confronto	- Nuovo sistema di welfare - Promozione dell'inclusione sociale
Istituzionalizzazione della cultura tramite nuove pratiche sociali	Valorizzazione e trasferimento del valore di dell'unicità dei capi	Creazione di valore sociale sotto forma di norme, pratiche, comportamenti, atteggiamenti	- Nuovo stile di vita etico - Nuovo modo di vivere la moda e nuovo status symbol sostenibile

Fonte: ns. elaborazione

Come conferma il responsabile delle relazioni istituzionali di Quid: "*i nostri clienti e i nostri partner sperimentano un nuovo modo di vivere l'abbigliamento, i consumatori sono porta voci di un nuovo life style basato sull'esigenza di possedere capi moderni, inusuali, esclusivi accompagnata però dalla consapevolezza che ciò che si indossa sia 'pulito'*".

Dunque, promanare i valori di Quid vuol dire condurre gli utenti verso una nuova concezione "pulita" ed etica della moda che mira a trasferire un senso di unicità oltre che di responsabilità "*a conferire un senso di prestigio ai capi dei nostri consumatori, che indossano non semplici abiti ma si rivestono di un vero e proprio status poiché oggi la moda non è più elitaria ma è popolare e se pure ricerca uno stile unico intende farlo non compromettendo la qualità dei materiali o mettendo a rischio lo sviluppo delle generazioni future".*

4.4 Risorse

Per ciò che concerne la variabile dell'allocazione e gestione delle risorse, Quid attua strategie di selezione dei propri fornitori basate sul reperimento di risorse rinnovabili e di implementazione di processi aziendali a ridotto impatto ambientale. L'azienda ha predisposto così una rete di fornitura che il responsabile della R&S definisce una "*social supply chain*". Egli sottolinea: "*Quid realizza le proprie creazioni quasi esclusivamente partendo da eccedenze di produzione di tessuto di alta qualità […] Spesso si tratta di metrature troppo ridotte per la grande produzione o dismesse per questioni legate ai trend o alle caratteristiche del tessuto".*

In questo modo l'Azienda è in grado di prolungare il ciclo vitale dei tessuti e di accorciarne la *carbon footprint* contribuendo al recupero e riciclaggio di una quantità enorme di tessuti e riducendo gli sprechi di risorse ed energia.

Alle strategie di allocazione delle risorse, Quid affianca strategie di creazione e scambio del valore basate su due principali driver (Tab. 5): 1) apprendimento organizzativo incentrato su scambio attivo di conoscenze e logiche di incentivazione all'apprendimento continuo; 2) gestione dei processi informativi e comunicazione trasparente tramite l'uso sinergico ed efficiente delle nuove tecnologie che aiutano anche a innalzare l'*engagement*.

In merito al primo profilo, l'azienda è in continua ridefinizione delle *skill* possedute dai propri dipendenti e dal *management*, il cui *know-how*, legato alla messa in pratica dei principi sostenibili, è incessantemente stimolato. L'apprendimento è inteso quale leva chiave per la cattura dei "segnali deboli" sia all'interno dell'organizzazione per l'eventuale emersione di creatività organizzativa, che al suo esterno per intercettare i mutevoli e nascenti bisogni degli utenti.

Come riportato dal manager delle risorse umane, "*dalla nascita dell'impresa ad oggi sono stati raccolti oltre 600.000 euro presso fondazioni locali e internazionali - tra cui Fondazione Cariverona e San Zeno - che sostengono investimenti strategici e percorsi di formazione*". Così, l'apprendimento continuo è stimolato altresì attraverso progetti di formazione.

Tab. 5: Principali risultati per la dimensione "risorse"

Principali driver (RQ1)	**Strategie di gestione dei driver**	**Strategie di gestione della creazione di valore sostenibile (RQ2)**	**Principali outcome per lo sviluppo dell'innovazione**
Sviluppo supply chain e value chain sostenibile	Creazione rete fornitura e distribuzione prodotti di materie prime "pulite"	- Allocazione e gestione risorse rinnovabili - Dematerializzazione prodotti; - Riduzione delle emissioni.	- Agevolazioni fiscali - Riduzione degli scarti di tessuto e maggiore efficienza produttiva - Potenziamento riconoscibilità sociale del progetto
Apprendimento organizzativo	Sviluppo di skill altamente qualificate tramite integrazione interfuzionale delle competenze	- Attività formative continue - Servizi di supporto psicologico e pratico/burocratico a favore del personale	- Aggiornamento skill aziendali - Management proattivo - Emersione creatività
Digitalizzazione dei processi aziendali Information management Gestione flussi comunicativi	Investimenti in piattaforme di comunicazione digitale: - portale e-commerce - sito istituzionale - CRM - Social network	Sustainable infrastructure-integrata per: - supporto nella definizione di concept di nuovi prodotti - armonizzazione relazioni; - gestione flussi informativi; - raccolta dati e stimoli creativi (feedback) per co-innovazione	- Maggiore capacità di "catturare" i bisogni espressi e non espressi di clienti e stakeholder (raccolta di *feedback*) - Sviluppo capacità di cogliere le tendenze della moda

Fonte: ns. elaborazione

Per quanto riguarda il secondo profilo, le pratiche di sostenibilità ambientale, economica e sociale gestite dall'impresa sono supportate, con l'intento di creare engagement, a livello strategico ed operativo dalla comunicazione aziendale sviluppata su piattaforme social e sul portale istituzionale. Dunque una *sustainable infrastructure* basata su integrati strumenti tecnologici non solo alimenta i flussi informativi e armonizza le relazioni, ma al contempo raccoglie costantemente il *feedback* degli utenti allo scopo di captare continui spunti innovativi.

I principali strumenti tecnologici implementati sono: 1) sistemi di gestione informatizzata del CRM (*customer relationship management*); 2) social network.

Il responsabile della R&S dichiara che l'azienda ha "*integrato il proprio CRM con un software di gestione dei processi produttivi (ERP) specifico per il settore moda. Questo investimento* ha *permesso di ridurre i margini di errore e rendere più efficiente la produzione monitorando al contempo consumi e costi"*. L'impresa, così, appare fortemente orientata al consolidamento degli investimenti in infrastrutture di rete e progetti di digitalizzazione, al fine di sostenere in modo efficiente ed efficace l'implementazione delle iniziative sociali e di business promosse.

La strategia di comunicazione sulle piattaforme social è elaborata in modo oculato. Tramite Facebook e Instagram l'impresa comunica rispettivamente il progetto e il prodotto - nello specifico le tematiche del progetto sociale e l'aspetto valoriale insito nella propria offerta - e attiva una raccolta di feedback implementata in modo automatico e creata informalmente. I canali social sono utili per creare engagement. Tramite Instagram, come riportato da un digital and communication manager, *"l'impresa sviluppa la propria ricerca nell'ambito del reparto stile e design con il supporto del team di comunicazione per interiorizzare nei modelli proposti l'andamento della moda etica in termini di stili, trend, richieste"*. In tal senso, stimoli e input contribuiscono a definire il concept di prodotto, il percorso narrativo della collezione, la scelta della location del servizio fotografico, la modalità di esposizione dei capi di abbigliamento.

Inoltre, l'impresa ha di recente ristrutturato il portale e-commerce per attivare *"una piattaforma più user-friendly con interfaccia più giovane, fresca, immediata, intuitiva, esteticamente più funzionale"*. Anche il sito istituzionale è stato dotato di un'interfaccia più agevole e soprattutto è disponibile anche in lingua inglese, la cui assenza rappresentava un grosso deficit per l'impresa, considerata la sua forte proiezione internazionale.

4.5 Partnership

La variabile *"partnership"* è riferita alla creazione di un complesso network di relazioni mediante il coinvolgimento di un variegato *set di stakeholder* così articolati: 1) risorse umane interne all'organizzazione; 2) potenziali collaboratori esterni all'organizzazione; 2) fornitori; 3) aziende non-profit: 4) imprese for-profit; 5) consumatori.

In merito al profilo interno, le risorse umane di Quid si sostanziano in un team coeso di *designer*, creativi, personale di sartoria, che sviluppa collezioni *limited edition* sulla base dei trend del momento. L'organizzazione si avvale inoltre di figure professionali altamente qualificate improntate al lavoro di squadra e all'iniziativa. I team incaricati dello sviluppo dei progetti moda e sociali collaborano a stretto contatto, il loro aggiornamento è continuo e tempestivo grazie ad una pianificazione strategica dei momenti di confronto che rafforza la condivisione della vision e ne favorisce una più efficace traduzione a livello operativo.

Per quanto riguarda il reclutamento di potenziali dipendenti, la valorizzazione delle diversità, l'integrazione dei migranti, la valorizzazione della leadership femminile sono le tre aree in cui - nella seconda metà del 2018 - Quid ha dato il via a un nuovo piano di CSR aziendale con l'obiettivo di potenziare l'inclusione attraverso il lavoro. Tramite il proprio brand di moda etica, l'impresa offre opportunità di impiego stabile e crescita lavorativa a quanti si trovano in circostanze di fragilità lavorativa, con particolare attenzione alla disoccupazione femminile e alla diseguaglianza di genere. Come conferma l'Amministratore Delegato *"negli ultimi cinque anni Quid ha indotto e supportato un maggiore investimento dell'impresa in capacità produttiva permettendole di assumere un numero sempre più elevato di lavoratrici svantaggiate"*. Egli aggiunge *"per il biennio 2019-2021, l'impresa si pone l'obiettivo di potenziare il raggio e la profondità del proprio impatto sociale"*.

Per quanto riguarda i fornitori, come evidenziato dal responsabile delle relazioni istituzionali, Quid *"ha consolidato negli anni la partnership con 40 fornitori tra i principali produttori europei e al mondo di tessuti di pregio"*.

Le *partnership* esterne sono avviate sia con enti non-profit, come la "Cooperativa Sociale Progetto Quid", una squadra di creativi emergenti che dal 2013 affianca il team dell'impresa; sia con aziende for profit mediante l'instaurazione di stabili collaborazioni. Difatti, progetti di co-design per la creazione di linee dedicate di accessori etici sono realizzati in partnership con 10 marchi di moda di rilevanza internazionale. Tali partnership nella visione del responsabile delle relazioni istituzionali "*sono state preziose per acquisire una maggiore riconoscibilità sociale del progetto, per il recupero senza oneri di rimanenze di tessuti, per l'ottenimento di spazi fisici da adibire all'attività produttiva o all'allestimento di temporary store, per la fornitura di servizi quali la promozione e il marketing di valori condivisi, la distribuzione di articoli realizzati in rete*".

Non da ultimo, interlocutori chiave di Quid sono i clienti, con i quali si stringono relazioni basate sulla fiducia condivisione e co-creazione del valore. In particolare, l'azienda riesce, tramite strategie di leadership proattiva e una gestione delle informazioni alimentata digitalmente, ad innalzare il loro engagement alimentato da un dialogo costante e del tipo *peer to peer* e da una comprensione delle loro esigenze.

Come evidenziato dal marketing manager, Quid introduce modelli di business "*collaborativi e basati sull'open innovation, cioè un'innovazione creata e co-creata dal basso che non soltanto prevede di identificare e rispondere ai bisogni della comunità ma che consente di prevederli e di contribuire ad arricchirli, orientandoli verso la sostenibilità*". La Tabella 6 riassume i principali stakeholder appartenenti alla rete creata da Quid.

Tab. 6: Principali risultati per la dimensione "Partnership"

Principali driver (RQ1)	**Strategie di gestione dei driver**	**Strategie di gestione della creazione di valore sostenibile (RQ2)**	**Principali outcome per lo sviluppo dell'innovazione**
Rete di relazioni con interlocutori e partner strategici	Collaborazioni e mantenimento relazioni con: 1) risorse umane interne all'organizzazione; 2) potenziali dipendenti esterni all'organizzazione; 3) fornitor/distributori; 4) aziende non-profit; 5) imprese for-profit; 6) consumatori.	- Creazione e condivisione della cultura sostenibile per un network *sustainable innovation oriented* - Coinvolgimento di un variegato set di stakeholder nella co-creazione di valore	- Inclusione sociale - Product development e service mirati all'eco-sostenibilità (Es. packaging) - Flessibilità tattica in base a strategie stabilite

Fonte: ns. elaborazione

4.6 Leadership

Il *management* di Quid sembra possedere una serie di competenze e abilità organizzative la cui natura dinamica pone l'impresa in grado di acquisire, combinare, trasformare risorse tangibili e intangibili in diversi modi, per affrontare con continuità le condizioni di cambiamento ambientale, rinforzare la capacità competitiva, migliorare le performance e offrire valore sostenibile. La *leadership* dell'azienda opera incessantemente per orchestrare in modo armonico le relazioni, i processi aziendali e il *fit* tra strategie e tattiche (si veda la Tabella 7).

Come evidenzia il responsabile delle risorse umane, è "*centrale la figura dell'imprenditore, una donna giovane, la cui capacità di guida è percepita dalla comunità interna ed esterna all'impresa come versatile, adattiva alla situazione, proattiva*". I suoi diretti collaboratori la descrivono come una persona "*costantemente partecipe nell'attività da svolgere, coinvolgente, proiettata alla condivisione delle strategie e delle conoscenze, aperta al confronto e al dialogo, orientata all'innovazione, protesa ad incoraggiare la connessione/coesione interna. Esprime una leadership visionaria e si affida alle competenze altrui*".

Dunque, flessibilità tattica e re-design proattivo del *business model* nel costante perseguimento di strategie sostenibili sono le capacità chiave mostrate dai soggetti alla guida di Quid. Inoltre, le competenze del management relative alla *lean green manifacturing* rappresentano leve chiave per la creazione di un'offerta sostenibile. Ma il "solo" *know-how* in merito alle pratiche eco-sostenibili non basta. Infatti, la fondatrice e presidente di Quid ha una formazione economico-manageriale è esperta di relazioni internazionali ed è specializzata sull'*empowerment* femminile. Come racconta il responsabile delle relazioni istituzionali, "*prima di fondare Quid all'età di 25 anni ha maturato una esperienza di lavoro nella cooperazione internazionale in India e Haiti* e *nel 2018 è stata finalista del premio europeo Women Innovator Prize*". Il management è costituito per il 90% da donne di età compresa tra i 25 e i 40 anni: apprendiste e professioniste che, dopo una formazione all'estero o in aziende leader della moda hanno scelto di mettere il proprio talento al servizio dell'imprenditoria sociale.

Spiccate competenze organizzative accompagnano lo sviluppo dei progetti dalla fase di ideazione a quella di implementazione. Ogni progetto è seguito da un *team* appositamente costituito e da un'attività di pianificazione strategica dei momenti di condivisione che rafforza l'engagement interno. L'operatività nella stessa sede, o comunque in sedi contigue, favorisce un aggiornamento costante e tempestivo. Un dipendente delle risorse umane afferma: *"Svolgiamo tutti i lunedì mattina una riunione di coordinamento a cui partecipano tutti i referenti dei team e* i *vice referenti e pianifichiamo riunioni specifiche tra team che collaborano strettamente"*.

In definitiva, grazie ad una sapiente mediazione tra strategie e tattiche e tra l'implementazione di una cultura sostenibile e la capillare raccolta di *feedback*, la *leadership* stimola e sviluppa il costante rinnovo di nuovi valori sostenibili co-creati all'interno e all'esterno dell'organizzazione,

mirando all'accrescimento del benessere in termini di produzione di sviluppo sociale, economico e ambientale continuo nel tempo.

Tab. 7: Principali risultati per la dimensione "Leadership"

Principali driver (RQ1)	**Strategie di gestione dei driver**	**Strategie di gestione della creazione di valore sostenibile (RQ2)**	**Principali outcome per lo sviluppo dell'innovazione**
Leadership con skill manageriali proattive e know-how sostenibile	- Capacità di rilevare i benefici in termini di costi e opportunità dei progetti sociali promossi a favore del personale - Armonizzazione processi e relazioni aziendali	- Creazione nuovo valore e rinnovamento dello stesso tramite istituzionalizzazione - Rigenerazione continua del valore nel tempo tramite processi circolari di scambio di conoscenza	- Well-being e crescita condivisa - Benefici molteplici per la comunità (ambientali, sociali, economici)

Fonte: ns. elaborazione

4.7 Sviluppo dell'innovazione sostenibile

La combinazione sinergica e la gestione strategica delle dimensioni di business analizzate (strategia, cultura, risorse, *partnership*, *leadership*) danno vita alla co-creazione di rinnovato valore sociale, ambientale ed economico, dunque sostenibile. Il *business model* di Quid persegue incessantemente la generazione di *outcome* economici, sociali e ambientali i quali sono ottenuti tramite la cura costante delle relazioni con una molteplicità di stakeholder coinvolti in modo proattivo. Lo sviluppo di attività sostenibili ha origine a partire dalla catena del valore, per poi proseguire con un nutrito *set* di *stakeholder* che condividono comuni valori etici. Il triplice obiettivo di sostenibilità si pone trasversalmente alla totalità dei processi aziendali che sono raccordati saldamente alle strategie di sviluppo e creazione del valore sostenibile, dando vita a profili innovativi tecnologici, di processo, prodotto-servizio ed in cui le tre sfere economica, sociale e ambientale sono interconnesse, alimentando la crescita della collettività.

Il modello di *business* implementato da Quid è stato riconosciuto a livello europeo come modello sostenibile orientato all'innovazione ambientale; in particolare per le attività di "*recupero di una grande quantità di residui di tessuto volto a evitare così lo smaltimento nelle discariche, suscettibili di produrre un potente gas a effetto serra, metano"*. Tale risultato è corroborato altresì dalle pratiche relative allo smaltimento dei rifiuti e alle ridotte emissioni ambientali: *"il consumo di energia associato allo smaltimento dei rifiuti è ridotto, con un effetto di abbattimento dei costi. Durante i primi quattro anni di attività Quid ha ridotto le emissioni di gas a effetto serra di CO2 per circa 18.000 tonnellate*". Parallelamente, in ambito sociale, l'approccio innovativo di business le è stato riconosciuto a livello europeo con il premio *Civil Society Prize* della Commissione Europea "Impiego e Affari Sociali"; ed inoltre nel 2018 Quid viene investita dell'*Impact Investment Fund Opes*, venendo considerata in grado di "*fare la differenza sul mercato del lavoro nazionale attraverso un'eccellenza tutta italiana*". L'impresa è stata inoltre segnalata come *best practice* nel rapporto "GreenItaly 2017". In tale *report* è dichiarato che il piano a lungo termine di Quid è quello di sostenere la creazione di un *Franchising Sociale* (livello strategico), replicando il suo progetto in altri contesti sia nazionali che internazionali.

L'impegno dell'impresa in termini di tutela e protezione dell'ambiente è stato riconosciuto anche in occasione dell'evento "Momentum for Change", nell'ambito del quale sono state premiate le attività e pratiche più innovative realizzate da persone, aziende, governi in cinque ambiti: iniziative femminili (*people*), finanziamenti per investimenti "*climate friendly*" (*profit*), soluzioni ICT, salute del pianeta e neutralità climatica (*planet*). Altro premio è inerente progetto "*From waste to wow*" il quale punta sulla moda sostenibile per contrastare i cambiamenti climatici (ambientale) e per lottare contro le disuguaglianze di genere (sociale), fornendo posti di lavoro a donne svantaggiate (economica). Ancora, in ambito di gestione delle nuove tecnologie, il premio "*Best Wwworkers*" ottenuto nel 2018 riconosce la qualità dell'impresa di declinare il *Made in Italy* alle

nuove tecnologie, mediante l'uso di social network. Il premio, come esprime il *digital e communication manager "ha voluto riconoscere la capacità dell'impresa di coniugare la valenza sociale e l'attenzione all'impatto ambientale con la capacità di trarre il meglio dalla rete e dalle opportunità della digitalizzazione*".

Non da ultimo, l'Azienda offre supporto e tutoraggio ad imprese *start-up* in termini di: formazione (risorse), valorizzazione delle risorse umane (*people)*, creazione di una rete di partner sociali e sostenibili, "*ampliando così coloro i quali possono trarre vantaggio dai metodi di economia circolare sostenibile sviluppati da Quid".*

Nella Tabella 8 sono classificate le diverse tipologie di valore esito dell'innovazione sostenibile perseguita da Quid.

Tab. 8: Principali risultati per la dimensione "sviluppo dell'innovazione sostenibile"

Principali outcome innovativi	Valore sostenibile realizzato	Tipo di valore (co-)creato
European Social Innovation Competition 2014	- Smaltimento dei rifiuti - Ridotte emissioni ambientali - Risparmio energetico - Abbattimento costi	Ambientale Economico
Impact Investment Fund Opes Civil Society Prize	- Inclusione sociale - Promozione sviluppo economico per tutti i segmenti	Sociale Economico
GreenItaly 2017	- Franchising sociale - Valorizzazione delle risorse umane - Creazione di una rete di partner sociali e sostenibili - Modelli di economia circolare	Sociale Economico
Momentum for Change	- Salute del pianeta e neutralità climatica - Valorizzazione lavoro femminile - Investimenti "climate friendly"	Ambientale Sociale Economico
From waste to wow	- Lotta ai cambiamenti climatici - Lotta disuguaglianze di genere - Incremento posti lavoro a donne svantaggiate	Ambientale Sociale Economico
Best Wwworkers	- Ridotto impatto ambientale - Valorizzazione del Made in Italy e produzione artigianale - Sfruttamento potenzialità nuove tecnologie	Ambientale Sociale

Fonte: ns. elaborazione

5. Discussione

I risultati illustrati consentono di rispondere alle domande di ricerca formulate. In particolare, la presenza dei principali fattori critici di successo per la creazione di un modello di *business* sostenibile (strategie, cultura, risorse umane, *partnership* e *leadership*) è stata rilevata all'interno delle attività e dei processi di Quid, come descritti dai soggetti intervistati. Inoltre, sono state rilevate le strategie adottate trasversalmente alla gestione di processo delle anzidette dimensioni (RQ1). Parallelamente, è stato possibile ricostruire per ciascuna dimensione il processo di creazione, diffusione, creazione e co-creazione di nuovo valore (RQ2) che si conferma come "intersecato" lungo le varie aree creando un ciclo perpetuo di *sustainable value creation* soggiacente ai processi complessivi di impresa. Infine, si è constatato come il triplice obiettivo di sostenibilità sia perseguito da Quid in tutte le iniziative aziendali e le pratiche innovative sviluppate, permettendo di riscontrare l'adozione di una strategia consapevole di innovazione sostenibile tramite la creazione di una cultura coesa, *stakeholder engagement* e di una *leadership* tesa ad ottimizzare i precedenti *key driver* al fine di generare innovazione sociale, ambientale ed economica. La capacità di creare valore sostenibile si fonda su un rapporto di fiducia reciproca tra l'impresa ed i propri interlocutori rilevanti. Il microcosmo di Quid è animato da collaborazioni co-partecipative e co-creative a livello strategico.

Ne consegue che il *business model* sostenibile e innovativo di Quid è dato dalla combinazione dinamica e sinergica dei seguenti *driver*, già ipotizzati come variabili della traccia dell'intervista ma

arricchiti di ulteriori sottodimensioni ed indicatori:

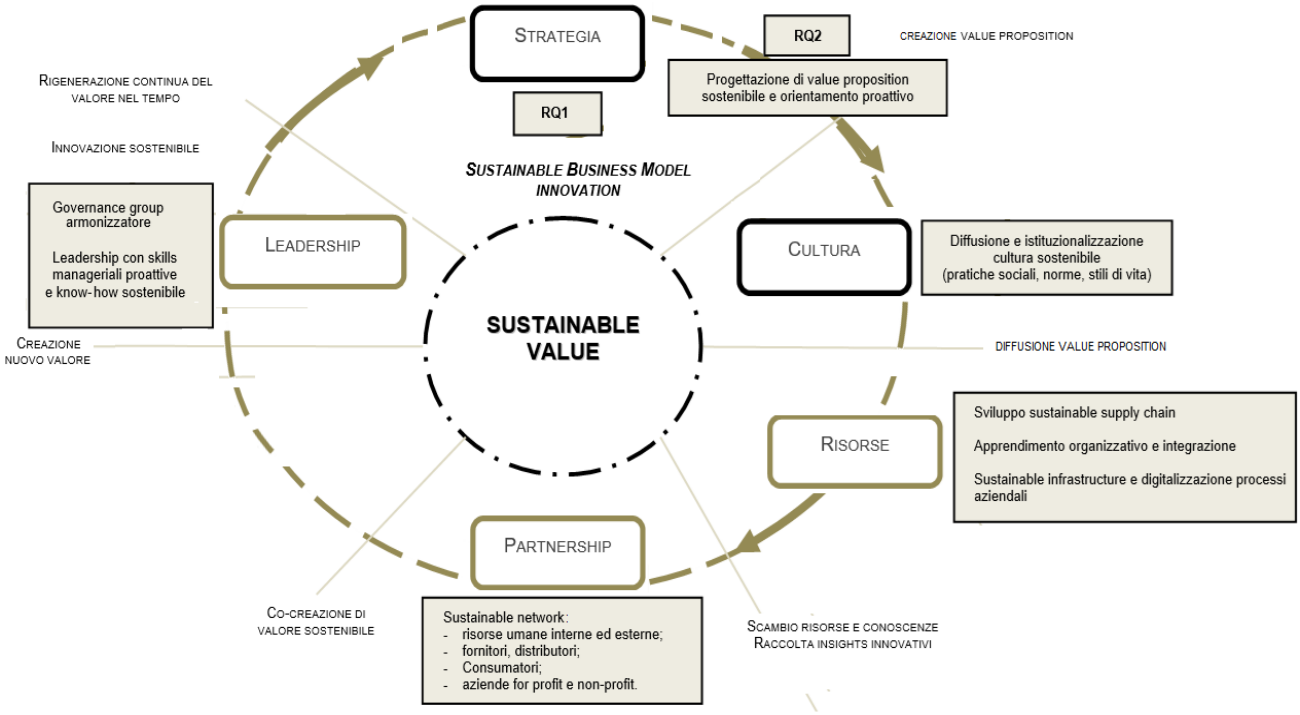
1) *strategia*: creazione di un orientamento alla sostenibilità e all'innovazione tramite esercizio di *leadership* proattiva, sinergica e meccanismi di condivisione;
2) *cultura*: diffusione di una visione condivisa, creazione di nuovi sistemi di *welfare* e norme e pratiche sociali derivanti dall'istituzionalizzazione dei principi sostenibili;
3) *risorse*: allocazione e scelta delle risorse più idonee per realizzare una *value chain* sostenibile, supportata da: attività mirate a stimolare l'apprendimento organizzativo; l'integrazione organizzativa delle competenze; la rigenerazione di un set di tecnologie per gestire i flussi informativi e comunicativi;
4) *partnership:* selezione di *partnership* in linea con l'orientamento sostenibile e le risorse possedute e ricercate tramite creazione di un *network* sostenibile di *stakeholder* (enti, aziende, fornitori, consumatori) orientati all'innovazione;
5) *leadership:* armonizzazione dei complessi processi aziendali, supporto all'arricchimento del valore, re-implementandolo nei continui "cicli" come cultura consolidata, stimolazione della produzione di innovazione sostenibile su base continua.

Rispetto alla classificazione delle dimensioni emerse dalla *review* della letteratura (Par. 2.2.2) sulla base dei risultati dell'analisi empirica emergono due principali aspetti in merito alla suddivisione dei processi di *resource allocation* e *resource integration* a) apprendimento organizzativo e continuo *up grade* delle competenze; b) gestione dei processi informativi e comunicativi tramite le tecnologie digitali.

Alla luce degli elementi evidenziati, la creazione di valore sostenibile è frutto di un cruciale orientamento strategico. L'idea di fondo è che la sopravvivenza aziendale è legata ad una duplice capacità: da un lato saper attrarre attraverso il proprio sistema d'offerta complessivo, le risorse migliori per garantire continuità e sviluppo alle attività; dall'altro lato rispondere alle attese degli *stakeholder* in modo coerente e consapevole, costruendo e rafforzando relazioni di mutua fiducia.

Le variabili finali ottenute tramite l'applicazione al caso Quid consentono di specificare ulteriormente le macro-dimensioni dei *business model* sostenibili identificate nella *review* della letteratura nelle seguenti sotto-dimensioni. A tal fine, viene proposto un *framework* per la SBMI (Figura 1).

Fig. 1: Il framework per la SBMI



Fonte: ns. elaborazione

La prima dimensione (*strategia*) è attuata attraverso la diffusione di un *orientamento alla sostenibilità*, testimoniato dall'attenzione continua del *management* alla tutela dell'ambiente (e ai diritti delle generazioni future), al risparmio energetico e alla minimizzazione degli impatti associati ai cicli di trasformazione, produzione e consumo, all'utilizzo consapevole delle risorse per contribuire alla promozione di una crescita responsabile e sostenibile del territorio in cui opera.

Per diffondere tale orientamento emergono due *driver* principali: 1) l'esercizio di una *leadership* proattiva e sinergica; 2) la creazione di meccanismi di condivisione e allineamento strategie-obiettivi.

Nel primo caso, si riscontra l'esigenza di una "*socially minded leadership*" proattiva tesa all'innovazione e al controllo sociale delle modalità di produzione e di distribuzione del valore, bilanciando gli interessi privati con quelli sociali, conciliando le attese degli *shareholder* con la valorizzazione in modo duraturo e sostenibile delle risorse naturali, umane e sociali (Arru, Ruggeri, 2016). Tale abilità organizzativa supporta l'ideazione e la realizzazione di prodotti e servizi in grado di soddisfare le esigenze, esplicite o inespresse della clientela; l'implementazione di investimenti tecnologici performanti i processi produttivi al fine di renderli maggiormente efficienti.

Nel secondo caso, i meccanismi di condivisione prevedono il costante allineamento della strategia emergente alle tattiche e operazioni implementate dall'impresa, da un lato, e ai valori individuali-etici dei consumatori, dall'altro.

La traduzione dell'orientamento sostenibile in una visione condivisa in seno alla comunità aziendale (*cultura*) avviene tramite la trasmissione e interiorizzazione dei principi sostenibili da parte dei membri aziendali. Un indicatore della creazione di un'efficace cultura sostenibile è la proposta di nuove norme sociali (in questo caso un nuovo sistema di *welfare*), di nuovi atteggiamenti, consuetudini o prassi (un nuovo stile di vita e modo di intendere la moda).

Un'azienda sostenibile non soltanto ha il compito di identificare risorse in linea con la propria strategia sostenibile (*risorse*), ma altresì mira al continuo rinnovamento di *skill* interne in grado di sostenere in tutti i processi aziendali la spinta all'innovazione economica, sociale e ambientale.

Per realizzare una *value chain* sostenibile, un'organizzazione deve sviluppare un set di risorse (interne e/o esterne) sostenibile allo scopo di ridurre le emissioni a livello di processi e filiera, mediante una rete di fornitura e distribuzione ad hoc che ridefinisca il *supply chain management* con canoni sostenibili.

Alle strategie di allocazione delle risorse, il *sustainable business model* efficiente dovrebbe affiancare le seguenti sotto-dimensioni: 1) apprendimento organizzativo basato sullo scambio attivo di conoscenze che stimola logiche di apprendimento continuo; 2) gestione dei processi informativi e una comunicazione trasparente tramite l'uso sinergico ed efficiente delle nuove tecnologie che aiutano anche a innalzare *l'engagement* (Pencarelli et al., 2019).

L'*apprendimento organizzativo* si riferisce all'acquisizione di conoscenze e competenze adottate nei processi decisionali, nello svolgimento di attività specialistiche e nella distribuzione delle risorse a supporto della gestione di pratiche sostenibili. In tale ambito è fondamentale una formazione continua utile a comprendere la complessità e le dinamicità connesse a tali processi e per interiorizzare un pensiero proattivo verso la sostenibilità promuovendo e adottando comportamenti socialmente responsabili. La complessità, la dinamicità e gli investimenti necessari per progettare e implementare processi aziendali sostenibili richiamano l'esigenza di una *integrazione interfunzionale* (Stone *et al.*, 2004), che l'impresa esprime nella forma di una intensa interazione tra i collaboratori afferenti a diverse aree funzionali (amministrazione e personale, *digital* e comunicazione, commerciale e *retail*, rapporti istituzionali, raccolta fondi, modelleria e stile, approvvigionamenti, magazzino e logistica). Inoltre, il processo di scambio delle risorse e la gestione efficiente delle informazioni e del *feedback* ricevuto dagli utenti viene armonizzato tramite la creazione di una *piattaforma tecnologica sostenibile* che supporta il business tramite la digitalizzazione dei processi (Pencarelli et al., 2019) con alcuni *tool* come i sistemi di gestione informatizzata del CRM o i social network.

La variabile *partnership* si configura come il complesso insieme di attività di identificazione e coinvolgimento di un variegato set di *stakeholder* con cui l'azienda ha generato un *network* di

relazioni. La *capacità di networking* con fornitori, clienti business, consumer, enti e istituzioni pubbliche e private, nonché personale interno, è un'abilità organizzativa che facilita l'interscambio di informazioni, la condivisione delle conoscenze e la collaborazione di lungo periodo assicurando rapporti fondati su una logica di co-evoluzione.

In definitiva, la creazione di nuovo valore può essere ottimizzata e perpetrata nel tempo in maniera sostenibile tramite il ruolo chiave di mediazione di una *leadership* che assicuri il raccordo tra strategie e tattiche aziendali e tra l'implementazione della cultura sostenibile e la costante raccolta di *feedback* dagli utenti per condividere e intercettare nuove istanze. In tal modo, stimolando e sviluppando il perpetuo rinnovamento dei nuovi valori sostenibili co-creati all'interno e all'esterno dell'organizzazione, il triplice obiettivo di innovazione sostenibile viene realizzato, portando con sé l'accrescimento del benessere e la produzione di sviluppo sociale, economico e ambientale nel tempo.

6. Implicazioni e conclusioni

Lo studio condotto ha consentito di migliorare la comprensione dei driver e dei conseguenti meccanismi attraverso cui un'impresa può promuovere creazione di valore integrato.

La realtà investigata "Progetto Quid" rivela una capacità di proposizione e diffusione di valore sostenibile che è profondamente radicata nel suo orientamento strategico oltre che nella cultura aziendale. Il modello di business, che presenta i connotati di innovatività e sostenibilità, è improntato su una visione olistica di tutti i fattori idonei ad assicurare un sapiente e continuo raccordo tra le strategie sostenibili aziendali e le tattiche, le pratiche, i processi implementati dall'impresa; tra la cultura organizzativa sostenibile e i valori individuali ed etici dei clienti di cui è importante raccogliere il *feedback* per poter intercettare nuovi bisogni ed istanze. Questo costante percorso e impegno di allineamento e di rinnovamento dei valori generati e condivisi all'interno e all'esterno dell'organizzazione necessita di essere supportato dalle relazioni e dalle interazioni che abilitano alla creazione e co-creazione del valore.

La ricerca nei suoi risultati complessivi contribuisce sia alla teoria che alla pratica manageriale.

Partendo da un *gap* riscontrato in letteratura inerente la mancanza di studi empirici che spieghino come un modello di business possa sviluppare l'innovazione orientata alla sostenibilità, e considerando la sostenibilità come una componente da amalgamare in modo sinergico in seno alle strategie di generazione dell'innovazione e a monte del modello di business, attraverso l'approfondimento teorico ed empirico svolto si è giunti alla proposta di un *framework* che concettualizza le categorie di analisi che orientano la *sustainable business model innovation*. Esso presenta una rilettura dei *business model* tradizionali in base ai principi della sostenibilità e, proponendo una visione di sintesi, definisce i *driver* della creazione e co-creazione di valore sostenibile e di innovazione sostenibile, integrando l'approccio *value-based* con i principi della *sustainable business model innovation*.

Nel *framework* elaborato la sostenibilità non rappresenta "semplicemente" un *outcome* dei processi aziendali, bensì assume il ruolo di *driving force* per lo sviluppo di innovazione sostenibile emergente da meccanismi dinamici e circolari di proposizione del valore. In questo modo la generazione e la diffusione di nuovo valore divengono processi da gestire in un'ottica di sistema tramite specifiche strategie di co-creazione per dare vita a innovativi *outcome* sociali, economici e ambientali tesi a contribuire allo sviluppo e alla crescita sostenibile in quanto supportati ed allineati da una cultura organizzativa sostenibile. L'esito del processo è la creazione di nuovo valore reciproco ed integrato (sociale, ambientale, economico). L'innovazione sostenibile può essere quindi generata mediante la combinazione dinamica e "unica" del valore, che emerge dal momento in cui si crea un nuovo valore, effetto del portato sinergico delle interrelazioni tra le conoscenze uniche dai membri di un'organizzazione o di una rete di organizzazioni. Esso non deriva dalla semplice somma di tali skill ma da un plus "relazionale".

Sebbene lo studio offra nel suo complesso interessanti spunti di riflessione, annovera alcune limitazioni.

In primo luogo, l'analisi di un'unica realtà aziendale operante nel *fashion* non consente di generalizzare i risultati ottenuti. Tale opportunità dovrebbe essere sostenuta da un campione più ampio di imprese che operino in differenti business e che rappresentino esperienze aziendali ad alto potere esplicativo, capaci di coniugare innovazione e sostenibilità nel processo di generazione e diffusione del valore.

In secondo luogo, lo studio è stato condotto nella prospettiva dell'Azienda e non tenendo conto anche del punto di vista degli altri attori inseriti nel suo sistema relazionale, rispetto ai quali i processi di co-creazione del valore sono stati analizzati nell'ottica di rilevare le strategie per una loro efficace gestione e gli *outcome* perseguiti in termini di innovazione sostenibile. Dunque, il corrente studio identifica le principali fasi che il management potrebbe perseguire a livello strategico per l'implementazione di un business model sostenibile e innovativo, in cui il ruolo del consumatore risulta essere onnipervasivo rispetto a ciascuna fase, sia perché- come dichiarato dai manager inclusi nel campione- questi è attivamente coinvolto in ogni *step*, sia perché l'impresa modula coscientemente strategia, cultura e selezione delle risorse, partnership e leadership in sua funzione e in funzione degli altri stakeholder. Se la ricerca ha per oggetto il punto di vista manageriale, futuri studi potrebbero esplorare l'analisi della percezione dei consumatori e delle pratiche da questi compiute mediante tecniche qualitative (intervista in profondità, focus group) o quantitative (*survey*), applicando concretamente il *framework* proposto.

Pertanto, un orientamento futuro della ricerca, al fine di esplorare maggiormente in profondità il processo di creazione di valore sostenibile, potrebbe proiettarsi sia verso un'estensione dell'analisi di business diversi dal fashion, sia verso il coinvolgimento nello studio di importanti attori quali partner, clienti, consumatori al fine di comprendere operativamente come si configurano i meccanismi attraverso i quali viene generata innovazione orientata alla sostenibilità.

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Appendice - Traccia dell'intervista

Topic 1 - Informazioni generali sull'Azienda
- Qual è la vostra mission aziendale?
- Quali sono le principali scelte produttive-distributive e come si compone la rete commerciale?

Topic 2 - Strategia
- Quali sono i valori chiave perseguiti dalla vostra azienda? In che modo questi vengono proposti e diffusi?
- Qual è la strategia e quali sono i piani futuri che guidano l'azienda?

Topic 3 - Cultura
- I principi della sostenibilità e del cambiamento sociale sono inglobati a monte della cultura aziendale?
- Vi sono delle attività volte a diffondere i valori chiave della cultura sostenibile?

Topic 4 - Risorse
- Quali sono le principali risorse che occorrono per la creazione di valore sostenibile?
- Ci sono strategie atte a regolare gli scambi di risorse?
- Che ruolo riveste l'impegno di specifiche tecnologie digitali nella vostra azienda?
- Qual è il ruolo delle tecnologie digitali nei processi di innovazione?

Topic 5 - Partnership
- Quali sono le principali partnership e collaborazioni attivate dalla vostra azienda?
- Come si compone la vostra rete di fornitori e distributori?
- Vi sono delle strategie-azioni formative orientate alla sostenibilità e destinate a membri interni ed esterni all'organizzazione?
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Topic 6 - Leadership
- Quali sono le capacità impiegate per gestire risorse e partnership in una logica di valore sostenibile?
- Vi sono delle strategie di gestione delle relazioni coi partner?
- I valori generati sono rinnovati nel tempo grazie al confronto con gli utenti e i partner e lo scambio di risorse?

Topic 7 - Sviluppo dell'innovazione sostenibile
- Cosa rappresenta l'innovazione sostenibile per la vostra azienda?
- Quali sono stati e quali sono i principali obiettivi sostenibili perseguiti attraverso lo sviluppo dell'innovazione?

Innovation in managing sustainability: a tentative of integration of an accounting instrument for employee health and safety

MASSIMO BATTAGLIA* MARCO FREY• LARA BIANCHI♠ EMILIO PASSETTI**

Abstract

Objectives. *The study analyses the implementation and integration of an accounting instrument for employee health and safety, and discusses whether and how the instrument and the related economic information support employee health and safety decision making.*

Methodology. *The analytical framework focuses on the technical, organisational and cognitive factors that may operate as enabling or hindering factors during the implementation and integration process of a certain instrument. A multiple case analysis of two medium-sized Italian waste management companies was carried out following an interventionist research approach over a period of almost two years.*

Findings. *The analysis reveals that neither of the two companies integrated the instrument despite the positive outputs that emerged during the implementation phase. A variety of interrelated technical, organisational and cognitive barriers emerged. In particular, the difficulty of generating strong organisational interest in the instrument prevented its integration. Cognitive factors, such as empathy towards workers and fear of potential new injuries, enabled the implementation but prevented the integration. The instrument, when adopted, was able to support health and safety decisions, even though the link between economic information and employee safety was uncertain and fragile.*

Research limits. *The study presents novel insights into the relationship between employee health and safety and accounting, which represents an unexplored and rich area of investigation for the social accounting community. The limitations of the study concern the potential biases related to the direct engagement within the organisations, which were, however, effectively managed during the research process and data analysis phase.*

Practical implications. *The results may support the development process of accounting instruments dedicated to employee health and safety. The results suggest that the integration of a new accounting instrument requires the concomitant presence of technical, organisational and cognitive enablers in cases where the new instrument represents a strong change from routinized ways of acting and thinking.*

Originality of the study. *The research offers a comprehensive analysis of the accounting instrument development process. The research also offers evidence concerning the potential of accounting logic to enhance employee health and safety, which to date has been discussed mainly in specialised health and safety management journals.*

Key words: *accident cost analysis; accounting development; cognitive factors; human capital accounting; social accounting.*

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1. Introduction

Occupational health and safety management aims to ensure adequate conditions for the hygiene, safety and well-being of people in the workplace. It seeks to facilitate the identification and reduction of risks, accidents and work-related diseases. The topic has become increasingly important for companies that have developed new policies, programmes and actions in response to the pressure applied by trade unions, new legislation and an increased societal sensibility (Swuste *et al.,* 2016).

In terms of the role of accounting, studies have discussed accident cost classification schemes (Brody *et al.,* 1990; Veltri, 1990), developed specific methods of analysis (Aaltonen *et al.,* 1996; Rikhardsson and Impgaard, 2004) and reviewed existing methods (Rikhardsson, 2004; Tappura *et al.,* 2015). At the institutional level, it has been promoted in business as a win-win logic, with the argument that preventive approaches to safety can generate an economic pay-off for companies and a health and safety pay-off for employees (EU-OSHA, 2010; ISSA 2013). In contrast, critical accounting studies have underlined that imposing economic reasoning on occupational health and safety is a reductionist approach that is unable to address the complexity of the topic and promote its ethical value (Caicedo and Mårtensson, 2010; Caicedo *et al.,* 2010; Dillard and Roslender, 2013). O'Neill *et al.* (2015) criticised the logic of using gravity and frequency indicators, arguing that they are too simplistic and aggregated to reliably communicate the information needed to guide company decisions or to inform public policy. Cooper *et al.* (2011) proposed that more transparent and inclusive accounting of the investments made to improve employee safety is needed to increase its importance.

In parallel, studies on the accounting instrument development process (Englund and Gerdin, 2008) have revealed the importance of organisational, technical and cultural factors in driving the dynamics of instrument implementation and integration (Anderson, 1995; Ax and Greve, 2016; Battaglia *et al.,* 2016; Contrafatto, 2014; Fraser, 2012; Lodhia and Jacobs, 2013; McLaren *et al.,* 2016). The complexity of ascertaining the accounting novelty and usefulness of addressing specific needs and the ability of new accounting instruments to add value in comparison to existing solutions remain contested (Busco *et al.,* 2015; Miller and Humphrey, 2012). However, despite the numerous studies investigating the development process of accounting instruments, it remains a central topic in understanding whether and how accounting influences organisational logics (Giovannoni and Maraghini, 2013; Modell, 2009; Wouters and Roijmans, 2011).

The main objective of the present study was thus to link the analysis of the development process of an accounting instrument with the analysis of employee health and safety. In particular, the study adopted a comprehensive framework based on technical, organisational and cognitive dimensions (Gond *et al.,* 2012) to analyse how enabling and hindering factors influenced the implementation and integration of an accounting instrument related to employee health and safety within two organisations. The focal instrument was the *accident cost analysis tool*, which provides economic information related to accidents in the workplace (Jallon *et al.,* 2011).

The research is important for two main reasons. Examination of the three dimensions and their inter-play is necessary to provide a fuller understanding of the implementation and integration process. The findings enhance our understanding of the role of the technical, organisational and cognitive factors that facilitate or hinder the complex dynamics surrounding the development process of an accounting instrument. The findings can also help to determine whether and how accounting and the related economic information can support employee health and safety decision making. Employee health and safety is often perceived as having meta-value for organisations (Bouten and Hoozée, 2016), while accounting instruments and economic information are considered secondary (Smallman and John, 2001; Miller and Haslam, *2009*).

Nevertheless, accounting instruments and economic information, when applied correctly, can operate to reinforce preventive employee health and safety approaches (O'Neill *et al.,* 2013). This is the case for the instrument analysed in this research, which was designed to collect, measure and analyse economic information concerning the absence of safety. The absence of safety is indicated

by the number, typology and frequency of accidents in the workplace; i.e., it indicates a company's failure in reducing and minimising the number of accidents. The aim of the cost analysis tool is to consider economic information as a metaphor for employee health and safety related failures, and to calculate the economic resources that could be invested to increase safety preventive actions. This safety accounting instrument focuses on the prevention of accidents as a value-creating activity. Rikhardsson (2004) pointed out a link between accidents and the initiatives taken to prevent them. The measurement of accidents is of critical importance because it can facilitate continuous improvement by inducing accident investigations and appropriate actions (Ibarrondo-Dávila *et al.*, 2015). The logic underlying the tool thus recognises the greater importance of employee health and safety compared with the economic dimension.

The empirical material was gathered through an interventionist study (Jönsson and Lukka, 2006) of two Italian waste management companies over a period of almost two years. Engaging with organisations through the co-design of specific projects is a research method that can offer very interesting theoretical and practical insights (Jönsson and Lukka, 2006), but, at the same time, it requires a concerted effort to report the details of the intervention and define the theoretical contribution (Malmi, 2016). While the technical details of the new instrument were reported in a dedicated publication (Frey *et al.*, 2013), this paper discusses the dynamics of interventionist study and the theoretical and managerial aspects related to the implementation and integration of the instrument. The adoption of an interventionist research methodology is appropriate for investigating employee health and safety issues. It encourages the participation of workers who are mainly exposed to the risks and thus can better perceive the lack of safety. It also links to the debate in the management accounting (Berry *et al.*, 2009; Malmi, 2016) and social accounting (Adams and Larrinaga-González, 2007; Correa and Larrinaga, 2015; Parker, 2005) literature about how research engages with practice, because it is able to combine theoretical rigour with practical findings. The research focuses on waste management companies because employees are subject to several risks in the workplace (Frey *et al.*, 2013). The Italian setting is also a relevant context due to the increased emphasis on health and safety management (Battaglia *et al.*, 2015).

The analysis theoretically adds to previous studies on the accounting development process that have illustrated the critical role of cognitive aspects (Englund *et al.*, 2013; Hall, 2016). In particular, the role of emotions related to employees' cognitive health and safety issues was central in (initially) mobilising and (later) stopping the development process of the instrument. The implementation occurred in one company due to the positive emotions related to the possibility of improving health and safety analyses and employees' conditions, whereas the other company encountered more organisational barriers. Cognitive factors played a key role in connecting, experimenting and maintaining the relationship between the accounting instrument, the related economic information and employee health and safety decisions. However, the integration of the instrument was hindered in both companies by the negative inter-play between various factors. These considerations also inform the normative concerns that are largely present in specialised health and safety journals (Zanko and Dawson, 2010).

At the empirical level, this study is one of the first to provide an in-depth empirical analysis addressing the analytical and theoretical challenges related to the development of an accounting instrument for measuring safety aspects. While the technical analysis of accounting aspects related to safety and the economic estimation of accidents in the workplace have been developed in specialised health and safety journals (Battaglia *et al.*, 2014; Ibarrondo-Davila *et al.* 2015; Rikhardsson and Impgaard, 2004), more can be done in the accounting domain to understand whether and how accounting is able to promote safety in the workplace (Cooper *et al.*, 2011; O'Neill *et al.*, 2015). The enhancement of safety in the workplace is an ethical, legal and strategic issue for organisations and society and must therefore be scrutinised accurately, also for what concern the role of accounting (Parker *et al.*, 1989). Practical and managerial contributions concern the identification of a series of specific factors that should be addressed to facilitate the implementation and integration not only of the specific safety accounting instrument analysed, but

also of other accounting instruments, not necessarily confined to those related to employee health and safety.

The remainder of the paper is structured as follows. Section 2 explains the theoretical framework. Section 3 presents the research method. Section 4 presents the findings. Section 5 provides the discussion, conclusions and future research directions.

2. The analytical framework

According to Englund and Gerdin (2008; 2015), further studies on the accounting development process are needed to understand how internal process dynamics occur, which dimensions and factors influence them and how they are intertwined. The development process of an instrument is usually articulated in the main phases of *initiation*, *implementation* and *integration* (Al-Sayed and Dugdale, 2016; Damanpour, 2014). The *initiation* phase begins when internal and/or external pressures to change emerge and the internal constituents of an organisation become aware of their needs, starting with the investigation of and search for possible innovative solutions. The *implementation* phase represents the transition period during which an organisation becomes skillful, consistent and committed to the adoption of the innovative instrument (Klein and Sorra, 1996). In the implementation phase, the scope, objectives, data collection and possible changes in the adopted technique and/or the organisational structure are discussed. The trial adoption and the initial acceptance of the innovative instrument take place during this phase. Implementation, therefore, is the gateway between the decision to adopt the innovation and its routinized adoption, which is typical of the integration phase. In the *integration* phase, there is a gradual acceptance of and search for multiple applications of the instrument. Accordingly, a common understanding of the instrument may emerge in the organisation, and the innovation loses its novelty. Full integration is achieved when the innovative instrument becomes entrenched and embedded, and its information becomes routinized. In such a case, the instrument is adopted to its fullest potential - thereby improving work effectiveness - and is integrated within the organisation.

Different dimensions and related factors can influence the implementation and integration phases of an innovative instrument (Anderson, 1995; Ax and Greve, 2016; Busco *et al.*, 2015). Gond *et al.* (2012) identify technical, organisational and cognitive factors as the most important. They carefully analyse what occurs internally when an organisation experiments with a certain instrument. The *technical dimension* (Anderson, 1995) considers the availability of information and whether and how the information is diffused within the organisation. In the case of health and safety issues, technical aspects indicate the possibility of tracing and observing injury cost data and information, and of implementing and integrating the measurement instrument(s) into the pre-existing health and safety management procedures, health and safety performance reports, dashboard and investment decisions (Ibarrondo-Davila *et al.*, 2015). The technical dimension is important because it allows the acquisition and sharing of information, thus increasing the organisational legitimacy of the instrument. In fact, when information is scarce, the decision makers may become risk-averse and consequently the implementation and integration of the instrument become more complex, reducing the level of acceptance (Ansari *et al.*, 2010). For example, Gosselin's (2006) review of activity based on costing adoption and implementation illustrated that the technical complexity of the instrument due to the high costs of acquiring and maintaining adequate information led to its abandonment.

The second dimension is the *organisational dimension*, which refers to how structures, processes and actors are organised around a certain topic (Hoque and Halam, 1999). Organisational mechanisms can be specific tasks and activities or cross-unit teams that combine different perspectives, knowledge and experiences and thus permit a fruitful internal debate. Liu and Pan's (2007) activity base costing implementation review identifies the training of employees as a key organisational enabler, while Contrafatto (2014) indicate the constituency of an internal unit specifically dedicated to social and environmental issues in shaping the implementation and

integration of social and environmental reporting. In the case of health and safety, Battaglia *et al.* (2014) indicate the importance of creating common meaning between the different organisational actors regarding the importance and relevance of measuring the cost of accidents at work. The organisational dimension can increase or decrease the visibility and importance of a certain instrument (Ansari *et al.*, 2010), and in turn may also reduce technical and cognitive barriers (Gond *et al.*, 2012).

The *cognitive dimension* analyses the cognitive aspects (Hall, 2016), i.e., the 'mental template that individuals impose on an information environment to give it form and meaning' (Walsh, 1995, p. 281). Cognitive aspects include the knowledge that is assimilated by individuals and that becomes part of their competencies. Cognitive frames serve to reduce the complexity of the internal and external environment and drive individual and collective decisions and actions (Englund *et al.*, 2013). For example, cognitive factors influence how employees decide to adopt an innovative instrument, how they perceive the expectations, reward and support for a specific instrument within an organisation and how the instrument will foster (or inhibit) the fulfillment of their values (Major and Hooper, 2005; Klein and Sorra, 1996). When a monetary perspective is taken to measure employee health and safety issues, cognitive barriers may arise inhibiting the implementation and integration of the instrument. A monetary perspective should not be however considered as the leading criterion for taking decision. Rather, accounting can contribute to fostering employee health and safety measurement, underlining the importance of preventive actions based on the analysis of a variety of information, including information related to economic aspects. In this case, an accident cost analysis tool may increase employee health and safety related knowledge, transparency and decision making. However, whereas at the beginning of the development process there is greater scope for experimenting with a new instrument, during the integration phase - when the pressure to fully integrate and routinize it increases - the possibility of tensions and rejection of the innovative instrument increases (Ansari *et al.*, 2010; Hopper and Major, 2007).

The three dimensions are linked to and interact with each other. To foster the development process, each dimension and its specific factors should operate in an enabling way (Gond *et al.*, 2012). However, the three dimensions can trigger implementation and integration phases differently, because enabling and hindering factors can exist concurrently and interact in different ways (Barki and Pinsonneault, 2005; Battaglia *et al.*, 2016). The analysis of technical, organisational and cognitive dimensions thus offers an articulated understanding of the process surrounding the development of the accident cost analysis tool, permitting a discussion of whether and how the instrument and the related economic information have been able to promote employee health and safety decision making (Passetti *et al.*, 2014). According to Cooper *et al.* (2011), to promote the right to safety in the workplace, new forms of health and safety accounting are needed that consider both monetary and safety aspects. The aim is to provide transparent and complete information on the nature of the expenditures undertaken and the estimated costs of safety improvements. The analysis carried out in this paper contributes to this point by discussing the potential of an accident cost analysis tool to supply economic information intended to promote employee safety. Nevertheless, it is important that monetary information does not undermine the ethical dimension of employee safety, which must be accepted, adopted and propagated in support of safety improvements (Cooper *et al.*, 2011). The following sections describe the characteristics of the research method.

3. Research method and data collection

The main characteristics of the interventionist research method

This study implemented multiple case analyses following the logic of interventionist research. Jönsson and Lukka (2006, p. 374) define interventionist research as 'a kind of field experimentation where the researcher […] seeks to determine the experimental situation through observation, acts on that situation in concert with the host organisation, observes process and outcome, and analyses

findings in view of the relevant literature'. The interventionist approach is considered particularly interesting for extending both scientific and managerial debate, although it has been only partially developed in the accounting literature (Malmi, 2016). As indicated in the literature, to be relevant, an interventionist study should be able to produce practical (i.e., *techne*), theoretical (i.e., *episteme*) and societally useful (i.e., *phronesis)* knowledge (Lukka and Soumala, 2014).

Interventionist research involves the analysis of two distinct but linked perspectives. The *emic* perspective reflects the active role of the researcher during the research phase. The researcher becomes a 'member' of the host organisation, observing and participating directly in discussions. The emic perspective allows the researcher to acquire an insider's view of what is going on in the case-organisation, with the potential to acquire critical information and deep insights that would otherwise be unavailable. The *etic* perspective refers to studying the case-organisation from the outside, allowing the empirical findings to be linked to a theoretical framework and relevant literature to make a theoretical contribution (Lukka and Soumala, 2014; Suomala *et al.*, 2014). Both perspectives are important and must be balanced to justify interventionist research (Jönsson and Lukka, 2006). The type of interventionist research differs according to the degree of intervention, i.e., modest or strong. A strong case is when 'the researcher-jointly with members of the target organisation-develops a new construction, tests its usability, and draws theoretical conclusions based on this process' (Jönsson and Lukka, 2006, p. 377). The aim is to change the work processes or instruments or influence the decision making of the host organisation through the design or redesign of specific aspects.

In the current research, a strong base orientation was followed for a large part of the research period because the research team developed the instrument in collaboration with the host companies, then supported the companies during the implementation phase to foster the changes in the work processes and decision making. Finally, through a step-back process of analysis, the theoretical aspects of the research project are explored in this paper. The construction of a close contact zone (Ahrens and Champan, 2006) and cooperation between the researchers and the two companies served two purposes. For the companies, it served to develop a practical application for their internal health and safety analysis. For the research team, the project provided an opportunity to test the scientific literature, discuss topics concerning employee health and safety evaluation and exploiting research skills on the ground to gather in-depth materials and information for academic purposes. The project was also endorsed and sponsored by the Fondazione Rubes Triva (hereafter, the Foundation) which is the official Italian entity devoted to the promotion of a safety culture within the waste management sector.

The data collection process

The interventionist research was developed within two medium-sized public waste management companies operating in Italy, here referred to as *Marche and Latium* (Table 1). The research began in September 2014 and finished in November 2016. The aim of the project was to develop a safety accounting instrument for measuring the costs of accidents, which had not been analysed previously by the companies. The calculative technology developed for this study was the *accident cost analysis tool*, given the noteworthy interest that accident cost analysis has attracted in the specialised health and safety literature (Jallon *et al.*, 2011).

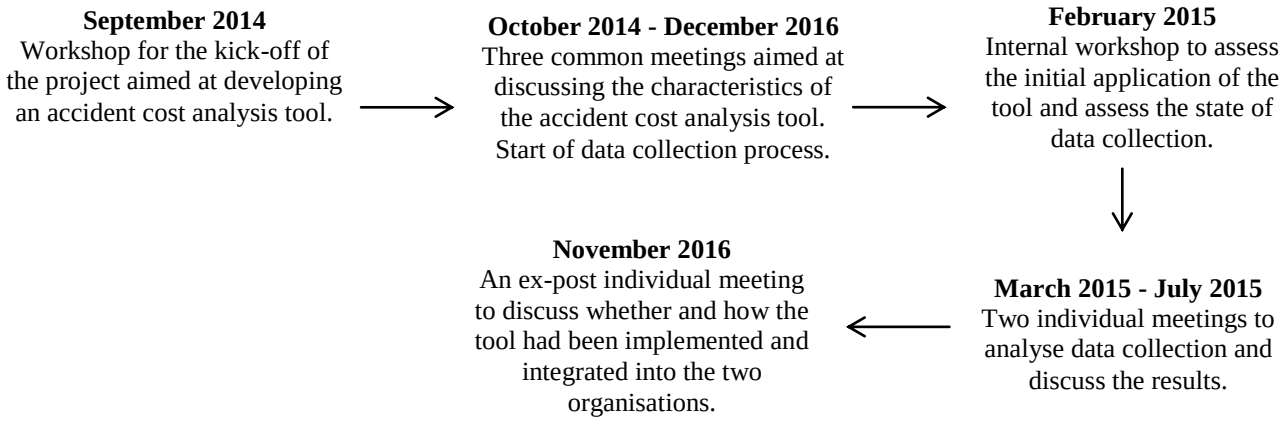
Tab. 1: Main characteristics of the case organisations

Characteristics	**Latium**	**Marche**
No. of municipalities Served	29 municipalities with around 138,000 citizens	5 municipalities with around 170,000 citizens
Waste management Activities	Urban waste collection by a mix of mechanised and door-to-door collections; landfill and incineration plant management	Urban waste collection by a mix of mechanised and door-to-door collections
Number of employees (2014)	414	325
Number of accidents (2014)	28	63
Safety indices (2014)	Frequency Index: 54.97 Gravity Index: 1.28	Frequency Index: 120.15 Gravity Index: 2.36

Source: company data

The tool was designed to provide monetary information concerning the activities related to the management of accidents occurring in the workplace, with the aim of supporting both ex-ante and ex-post-accident analyses and decisions. The timeline of the project is shown in Figure 1. Site visits, internal workshops and interviews mobilised the etic perspective, permitting the research team to observe and collect a great amount of data and information. To create an open and participative research environment, in most cases the meetings were not recorded, thus allowing for greater confidentiality and fluency between the researchers and the staff. During the meetings and interviews, extensive notes were taken and reviewed immediately after. The companies provided internal documents, which facilitated data triangulation and interactions that were perpetuated through e-mail and phone calls. The material collected was organised into a table listing the interactions with the companies. The following data were recorded (when applicable): date of the meeting, participants, topics discussed, critical aspects, time length and link to the meeting notes.

Fig. 1: The timeline of the research project



Source: our elaboration

One of the main risks of interventionist research is the possibility that the researchers, through their involvement with the organisation, lose their independence and autonomy concerning the evaluation of results (Arnaboldi, 2013). In this regard, the role of the research team evolved and changed during the project. Initially, the team operated as a technical translator (Arnaboldi, 2013) to offer the necessary knowledge to the participants and to favour the implementation process. This phase involved the design of the instrument, testing of its applicability and discussion of the potential usefulness of the information for decision making. Then, during the central implementation phase, the research team became a sidelined mediator (Arnaboldi, 2013), operating to guarantee a convergence of interests between the researchers and the companies. As indicated by Arnaboldi (2013), if the convergence of interests fails, the value of the project may decrease. In

particular, the research team produced two interim reports on the technical aspects and two formal presentations on the academic literature between September 2014 and February 2015. Such analyses laid the foundations for both the theoretical analysis and the practical implications. During this phase, the importance of focusing on the technical and organisational dimensions emerged.

From July 2015 to November 2016, the role of the research team changed to one of an assembling explorer (Arnaboldi, 2013). In this phase, the technical and organisational findings were openly and extensively discussed with the companies and compared with the initial aims of the project. This dialogue with the companies helped to create a balance between the emic and the etic perspectives (Soumala *et al.*, 2014), to refine the initial ideas and concepts and to produce the second intermediate step related to the theoretical analyses. A book was written and presented at a public conference as one of the outcomes of the project (Frey *et al.*, 2013). The book discussed the importance of managing and measuring employee health and safety performance, the accounting safety tools available in the literature for measuring accidents and the social impacts of injuries in the workplace; it also presented the economic data concerning the accidents collected and analysed during the project.

Once the project was completed in November 2016, the research team concentrated its efforts on developing the theoretical analysis through an ex-post reverse analysis (Jönsson and Lukka, 2006). In this phase, the materials and experiences collected during the project were interpreted and analysed through extensive reading on the accounting development process and the occupational health and safety literature. The in-depth reading revealed the importance of the cognitive dimension as an enabling/hindering dimension associated with the accounting instrument development process and employee health and safety, and helped to contextualise its importance within the interventionist research. An in-depth analysis of the notes, materials and experiences was also developed around eight key themes: health and safety performance measurement, accident analysis, health and safety reporting, technical factors, organisational factors, cognitive factors, interaction mechanisms and decision making. The research team discussed the different factors, attitudes, motivations and meanings underpinning the observed actions and behaviour. Discussions were held on whether and how the dimensions and factors were bundled together, how they influenced the development process, and the link between economic information and employee safety issues. As there was interactive movement between the two perspectives throughout the entire project, the ex-post reverse analysis of reflection and interpretation allowed the analytical unbundling of the emic and the etic perspectives (Soumala *et al.*, 2014).

The final phase of the research coincided with the writing of the academic output, and was also characterised by practical and societal contributions (Parker and Northcott, 2016). The problematic story narrated in this paper is evidence that the process of qualitative data positioning accurately corroborated the authenticity, plausibility and critical aspects of the two cases (Golden-Biddle and Locke, 1993). The narration of both positive and negative aspects of the research project avoided a second potential drawback of interventionist research, i.e., the biased representation of a successful story. The latter occurs when the researchers unduly guide the empirical research process toward the expected positive findings (in the case of this research, the full integration of the instrument within the two organisations), and selectively look for empirical evidence to confirm a positive story (Rautiainen *et al.*, 2016). In the next section, the cases analysis informed by the theoretical framework is illustrated.

4. Comparative field analysis

This section details the analysis of each company's data, starting with a discussion of the initial situation, followed by the implementation and integration aspects.

4.1 Initial situation

Marche - The initial situation

Marche began to focus on employee health and safety management during the first decade of the new century with the creation of a small internal unit dedicated to health and safety. The OHSAS 18001 was officially acquired in 2011 and was considered an important instrument to communicate, both internally and externally, the increased importance of health and safety management. Investments in technical and training aspects were made to increase employee safety at the operational level. The general director, however, was not completely satisfied with the way health and safety performance was measured. He did not consider the indicators (gravity, frequency, near misses, etc.) sufficient to fully explain the way in which the organisation was managing the issue. For example, the company still did not know the exact expenditure on health and safety management over the years. In addition, the analysis of health and safety performance was too localised within the health and safety unit and not shared within the organisation.

Latium - The initial situation

Latium first began to invest significantly in more proactive management of health and safety issues in 2007, as a consequence of the large number of accidents that had occurred in the previous years. The number of accidents had been reduced by half by 2010, and by two thirds by 2014. In 2008, an internal unit for the management of health and safety issues was created, which promoted a series of innovative health and safety-related initiatives over the years: new training courses for employees, replacement of old waste collection vehicles with more technologically advanced ones and the creation of a health and safety management system (without certification). The implementation of the health and safety management system allowed regular measurement of the frequency and gravity indicators and near misses.

4.2 Preliminary acts

Marche and Latium - The preliminary acts

In April 2014, the Foundation promoted a public conference dedicated to the promotion of a safety culture within the waste management sector. Several themes were discussed, including the importance of promoting health and safety management systems amongst environmental hygiene companies, the role of training at the operational level and the importance of measuring accidents in the workplace at a monetary level. The Foundation, and in particular its director, considered this last topic crucial for improving the top management’s awareness of preventive health and safety approaches. A project articulated in two phases was launched during the conference. The first phase consisted of a survey on the development of a health and safety management system in the sector. The aim of the second phase was to develop a project on the ground, in which companies would have the opportunity to cooperate with a research team on the development of a dedicated safety accounting instrument to measure the costs of accidents. The second proposal captured the initial interest of four companies, and in particular of the general director of Marche and of the human resource manager of Latium.

After a series of preliminary contacts to validate the initial interest in the project, in September 2014 an initial meeting was held between the Foundation, the research team and the two companies, represented by the general director of Marche, the human resource manager of Latium and their respective health and safety managers. The meeting defined the aim of the project and its timeline. A discussion about accident costs and their measurement was stimulated, during which the research team explained that in medium-sized enterprises with a relatively low number of accidents per year, the absence of a measurement process and the lack of dedicated instruments may lead to a misperception of the accident risk and of the costs associated with it.

4.3 Implementation phase

Marche and Latium - The common implementation phase

The design of the instrument was discussed during three meetings held between October and December 2014. In the case of Marche, two employees of the health and safety management unit and the accounting manager participated. In the case of Latium, two employees of the health and safety unit and an operational services middle-manager were present. In the first meeting both companies presented their profiles, explaining their operational characteristics and how they managed employee health and safety, as well as how they measured accidents. The research team presented the potential costs associated with accidents, including the cost of replacing an injured worker, the cost of the staff involved in the accident, the cost of investigations, the cost of sanctions against the company, insurance costs, the costs associated with the plant shutdown, the cost of training new employees and so on. The differences in costs between severe and non-severe accidents were discussed. The first meeting familiarised the companies with the project's aims. It also revealed the health and safety units' high commitment to enhancing the work safety of employees in everyday life.

During the second and third meetings, three methods for measuring the costs of accidents were discussed: insurance-based, activity-based and labour capacity-based methods (Battaglia *et al.*, 2014). The strengths, weaknesses and potential for implementation and integration within the two organisations were discussed. The health and safety units were particularly interested in the activity-based method due to the possibility of mapping all activities associated with an injury. Activity-based methods document all of the activities (consequences) generated by an accident and evaluate the costs of the activities (Battaglia *et al.*, 2014). The accounting manager of Marche also sponsored this method, indicating that a very precise identification of the activities would facilitate data acquisition and representation. Accordingly, the research team and the companies' representatives decided to focus on this method.

Three specific instruments were scrutinised to identify the most suitable: the accident consequence tree method (Aaltonen *et al.*, 1996), the systematic accident costs analysis (Rikhardsson and Impgaard, 2004) and the incident cost calculator developed by the Workplace Safety and Health Council of Singapore[1]. The three instruments showed very similar characteristics. However, none of them completely satisfied the requirements of the research project for a flexible, comprehensive and clear instrument to implement and integrate. Specifically, the accident consequence tree was considered to contain too many categories and items also considering the time needed to collect data and information. The systematic accident costs analysis lacked some items concerning the consequences of accidents, and thus it was considered unsuitable. The meanings of some of the items in the incident cost calculator were unclear and some information was considered difficult to find. An internal report was produced by the research team highlighting the pros and cons of each of the approaches.

Given the limitations of the available methods, the participants decided to develop an ad-hoc instrument based mainly on the existing ones, but without their disadvantages. The new instrument was named the *accident cost analysis tool*. It is composed of thirty-one specific items related to the management of an accident, grouped into five main categories of potential costs[2] [2]. Category A focuses on those activities associated with the initial consequences of the accident, category B on the administrative consequences, category C on the possible effects on the equipment, category D on the costs of resuming business activities and category E on compensation and penalties.

During the meetings, the company's representatives presented two main observations. Technical observations concerned the possibility of obtaining certain data and information that were not usually traced. The organisational perspective underlined a lack of knowledge and experience in

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1 The Incident Cost Calculator (ICC) is an interactive electronic tool. Details can be found on the official website of the Workplace Safety and Health Council of Singapore (https://www.wshc.sg/).

2 Due to space constraint the structure of the accident cost analysis tool has not be included in the paper. Please refer to correspondent author for a copy.

applying the instrument and in discussing the related information. To facilitate the data collection and analysis, a set of 'rules of thumb' were collectively defined as follows: (1) not all of the items had to be analysed for each accident because their presence depended on the gravity of the accident - the higher the gravity level, the higher the number of items to be included; (2) the value of each item had to be calculated as a total amount or unit amount of time depending on the nature of the item; (3) the owner of the data collection process was the health and safety unit, due to its local knowledge of practices and procedures related to accidents; and (4) the companies would conduct the experiment in a flexible way according to the time they could dedicate to data collection and analysis. The discussion also underlined that the data acquisition did not strictly depend on the accounting information system because some information had to be collected appositively.

The research team noted a progressive clarification of the purpose of the instrument for the health and safety units, which started to reflect upon the economic costs related to the accidents and on the operational implications of the information collected. The activities map was considered important for discussing the complexity of accidents, especially the most severe ones. It was used as a check list that could help to coordinate the different organisational areas involved in the management of an accident. The participation of the accounting manager of Marche was constructive because he helped to clarify how to measure the different activities related to an accident. The operational services middle management of Latium underlined some potential difficulties with the day to day activities because he considered the adoption of the instrument a major change to the routine way of acting. A discussion of data availability was followed by a plan for setting up the data collection process. In this regard, it was decided that each company would operate separately.

Marche - The specific implementation phase

For Marche, the data collection process was divided into a pilot phase and a main phase. The pilot phase focused on the analysis of four accidents with the aim to test the clarity of the items that composed the tool, the time required to acquire the data and to increase the health and safety unit's confidence in the data collection process. Despite some difficulties related to data acquisition, the pilot phase was evaluated positively and the general director of Marche decided to extend the analysis to a broader set of 20 accidents. *This represented a large set because it included almost half of all accidents that occurred from mid-2014 to mid-2015. The main phase included a selection of different accidents to ensure a complete representation of all kinds of accidents (not severe, severe and acute, depending on the number of days lost).*

The main phase, however, was more demanding than expected, as clarified in the subsequent meetings that occurred between February and July 2015. An *employee had to manually collect almost all of the information on each of the 20 accidents. As expected, neither the accounting information system nor the specific health and safety instruments already in force, such as the OHSAS 18001 and the accident report analysis, contained enough information to complete most of the items that composed the tool. For half of the accidents, the costs were calculated following ex-post logic (i.e. after the accident occurred), while for the other half the costs were calculated concurrently with the accident. In this second case, the data collection process was more fluid and manageable compared with the ex-post reconstruction, because the data were collected in real time. The research team and the internal health unit screened all 20 of the cards that were compiled to check the data validity and reliability. Technically, for each accident, an average of 10 out of the 31 available items were compiled, most of which were in categories A and B, with acute accidents being particularly relevant from an economic point of view.*

From an organisational perspective, the data collection process was characterised by the partial participation of the human resources office and the technical service (i.e., the area that directly manages the waste collection activities). The human resource office supplied some information concerning the items in categories B and C. However, the need for a series of reminders from the health and safety unit highlighted the difficulty of modifying the accounting information system to automatically collect the information. The technical service had a minor role

in the data collection for category A, increasing the difficulty of collecting complete information. The technical service units normally compiled a short accident report for the health and safety unit containing basic information on the accident. Instead, the tool required a more active approach by the technical service towards the health and safety unit, requesting a higher level of accountability concerning the ex-post activities related to the accident. The technical service contested the trade-off between on the one side managing the accident and the completion of the shift, and on the other side, the difficulty of supplying the information requested.

The technical service manager explained that in the case of a minor and non-severe accident, the work-shift team was oriented to finish the service without specific emphasis on the accident because it would not generate any particular physical consequence for the employees. Conversely, in the case of a severe accident, attention was directed towards the injured person with no time to collect and analyse the different activities listed in the tool. Further, the request to participate in data collection was perceived as 'politically' oriented, as a way to better control their behaviour rather than to increase the accountability process. *The technical service did not understand the purpose of collecting information concerning the activities in category A (i.e.* the cost of the incident management) *of the instrument. The new analysis was therefore perceived to be in contrast to the traditional organisational routines related to the management of an accident because the aim of the analysis, and of the related project, was not clearly communicated. These two criticisms were reported by the health and safety unit during the March meeting. In the meeting, Marche's representatives underlined the difficulty of engaging the technical service in a deeper discussion about the implementation of the instrument because it was considered an inappropriate tool for managing accidents.*

As a consequence of technical and organisational difficulties, the development of the instrument was in serious danger of being stopped due to the joint effects of a lack of time, some organisational differences and a lack of clarity on how the data would be used. It was critical to manage this latter cognitive aspect during the implementation phase. The research team noted that the health and safety manager had some difficulty defining how to exploit the data collected for decision making. The health and safety unit wanted to avoid wasting time in a pure data collection exercise, but instead wanted to exploit the information collected. The research team explained that merely visualising the costs of accidents could be considered a positive effort because it permitted a deeper analysis of employee health and safety performance. The results were subsequently presented to the general director in an official meeting during which the new information was widely discussed.

The analysis of the accidents showed which types were more costly. For example, the information on the door to door waste collection accidents indicated that these types of injuries were the most expensive and consequently needed more accurate training. From an organisational perspective, the information enabled the identification of some micro-organisational efforts that the health and safety unit had not previously been fully aware of. An example was the time taken by staff for managing administrative duties and the time to carry out extra activities to comply with ad hoc external audits by public authorities, all of which information was hidden before the application of the instrument. *The cost information* related to the injuries concerning -climbing and descending the lorries- highlighted the possibility of making comparisons between new preventive investments in employee health and safety and the potential incoming costs of the accidents associated with the status quo. *An economic simulation was also performed on the data, to calculate the total costs of accidents for 2012.* The analysis showed a total cost of just over €55,000 for the sample of accidents analysed (with a unit cost for injuries slightly lower than €2,000 for an accident of medium gravity), corresponding to an estimated annual value of about €120,000 for all of the accidents.

The general director appreciated the results. He expressed the desire to integrate the tool to support planning and control activities related to employee health and safety. His *appreciation was important to support as well as promote the health and safety unit employees' efforts due to the great commitment that they made to collect the data.* Accordingly, despite the presence of technical

and organisational barriers, the assessment of the implementation phase was considered prospective. Further, due to the feedback and explanations given by the research team, the internal unit appeared to be much more cognitively confident about how and when to use the instrument. The definition of the role of the instrument in supporting operational and performance analysis and in supporting specific investment decisions was thus very important because it clarified when and how to adopt it during decision making, thus escaping from the potential trap of considering the economic information as the leading information. In order to integrate the instrument, Marche decided to follow an incremental implementation path. This meant that a series of small initiatives needed to be taken. It was also established that the integration phase should be conducted autonomously by the company with the research team as 'external observers'.

Latium - The specific implementation phase

After the common design of the tool, Latium decided in February 2015 to collect information on all 28 accidents in 2014 in a single phase. The data collection process was similar to that for Marche. The cost of accidents was manually calculated because a large portion of the data and information was not available. The health and safety unit made a painstaking analysis of the internal documents with the aim of obtaining as much information as possible. The other information was collected in collaboration with the human resource office while the operational unit was not involved in this phase. According to the health and safety unit, the operational unit required specific ex ante training concerning the aim and purpose of the tool, otherwise the analysis could be interpreted as an attempt to cut, rather than to increase, safety aspects.

The research team actively supported the internal staff during data collection, progressively checking each accident report produced and helping them to clarify the meaning of some items. The health and safety unit highlighted that despite an initial problem with the data collection, and especially the information related to the time the operational unit dedicated to the management of the accident, the analysis of the accidents gradually became more standardised and reproducible. The health and safety unit noted that similar accidents required similar management time. The same observation was made by the human resource office, which noted that the administrative time dedicated to the management of the activities listed in the tool was very similar among the various accidents. Both offices thus gave a positive evaluation of the data collection process. They underlined that with some modification of the items in the accident report usually compiled by operational units, the cost analysis process could become faster. The health and safety manager was also confident that the incoming OHSAS 18001 certification would favour a more organic collection of the health and safety information.

From an economic point of view, the calculation showed a total cost of approximately €50,000 and an average cost per medium gravity accident of €1,900 (very similar to Marche). As noted during a meeting in April 2015, the large majority of the costs (more than 90%) were related to category A, then to category B, and, in the case of severe accidents (lasting more than 35 days), to category C of the tool. When compared with previous studies, the average cost of a medium accident was minor. The benOSH study (European Commission, 2011) reported a value of €1,651 for a low severity accident, of €4,985 for a medium severity and of €11,760 for cases with high severity. The results of the benOSH study indicated that the most important consequences of accidents were linked to the human-related aspects which accounted for 80% of the total cost.

The reaction to the new information was different from that at Marche. Whereas in Marche the health and safety office was initially more interested in the numeric value, in Latium the attention progressively moved to the analysis of the organisational aspects. The two offices of Latium recognised the value relevance of the monetary information, but they underlined that the majority of the cost was caused by the employees' absence from work after the accidents. They highlighted that most of the costs in category B were related to administrative time that could also be considered general time. In their view, the new information was interesting not only because it explained the economic value of an accident, but also because it indicated the areas and operational activities that were more risky. The analysis of accident cost reports revealed the importance of focusing on equipment, procedures and machines as the core aspects for improving employee health and safety.

The analysis therefore indicated the importance of improving organisational procedures and the relevance of continuing to invest in equipment and machines to reduce the number of accidents. In sum, the experimental adoption of the accident cost analysis tool was regarded positively because it showed an alternative and complementary view of health and safety performance and related managerial aspects. Latium, however, also questioned whether the economic measurement of accidents might be conceptually too risky because its aim could easily be misinterpreted as a way to reduce, rather than to improve, safety aspects.

The data were then presented to the head of the operational unit in a meeting in July 2015. The discussion that took place concerned the possibility of showing the organisational complexity of an accident and the cost of accidents during the training course for operational staff. The head of the operational unit agreed on the value added of the information, due to the possibility of increasing safety awareness. However, the proposal was only partially implemented because the health and safety unit, in conjunction with the operational unit manager, subsequently decided to show only the list of activities related to the accident and not the economic information. This precautionary approach was taken because the operational units were not confident about the usefulness of economic information when referring to safety aspects. Such representation could have produced potential discussions if the aim and purpose of the instrument were not well understood. In Latium the implementation was regarded positively by the human resource head manager, who was the head of the project, although it was not clearly sponsored by the head of the company. The idea of integrating the instrument was considered, as discussed in the following section.

4.4 Integration phase

Marche - The (no)-integration phase

In 2015, more than a year after the end of the experimental implementation, a one-day meeting was organised to understand whether and how the integration had occurred. The meeting revealed that the health and safety unit operated to promote organisational integration at the operative level. The activities map was used during the training of the workforce to *inform all employees of the organisational consequences associated with accidents, underlining the value added of active collaboration during the ex-post analysis of the accident. As reported by the safety manager, the operational workers were very surprised when they understood the organisational consequences related to an accident. The economic information was also presented to promote more rigorous conduct among the employees. It was expressed that such information could be considered a waste of company resources that could otherwise be used for preventive interventions and actions. According to the health and safety unit, the visualisation of economic information would encourage the operational staff to pay greater attention to certain safety procedures. The* internal union representatives also appreciated the ability of the activities map to raise awareness with regard to accident-related effects.

In term of decision making, the health and safety unit adopted the accident cost information *to forecast the potential costs of accidents for 2015. The determination and visualisation of the incoming costs underlined the importance of searching for new and effective safety operative solutions. The health and safety unit also adopted the information to support small investment decisions. It compared the data on* manual handling of loads and door-to-door waste collection accidents with the potential benefits (measured in terms of cost reductions as a consequence of fewer accidents) derived from increasing the level of safety and technology of the employees' equipment. The data were analysed following a cost-benefit logic, in which the measurement of benefits also took into consideration the economic benefits related to the reduction of accidents. Nevertheless, the health and safety manager clearly expressed that the economic information was complementary, and not the main criterion on which to take decisions. This point resonates with Hall's (2010) view that accounting information can be used not only in terms of well-defined decision scenarios, but also for improving knowledge regarding work environments.

The initial positive climate around the instrument and its use were not, however, sufficient conditions to integrate the tool. The health and safety unit recognised a difficulty in regularly updating the instrument when an accident occurred. They revealed that an official tentative aim to share some aspects of the data collection process was made in collaboration with the accounting unit, but neither the technical unit nor the human resource office replied in a positive manner. The technical unit indicated that the tool was not completely appropriate for analysing safety aspects, while the human resource office was only willing to act in a supportive role because they did not want to take any kind of responsibility on the topic.

A further barrier to the integration was the change of the general director, which occurred twice in a year, creating a sense of uncertainty in the company. As underlined by the internal unit, '*the absence of the past general director was detrimental to positively conclude the final development phase of the instrument*' because he had known and sponsored the entire process, while it was necessary to re-explain why and how the project and the instrument had been experimentally implemented to the second incoming general director. It was clear that the health and safety unit was rather isolated in pushing the integration of the tool due to a lack of support and endorsement within the organisation. A sense of demotivation was evident during the meeting, as expressed by the health and safety manager due to the great efforts they had made during the entire project. The research team made some attempts to re-open the discussion, highlighting that the abandonment of the instrument in the final stage would be counterproductive, but the health and safety unit did not change its decision to stop the integration process.

The presence of intertwined technical and organisational barriers, and the difficulties of overcoming them, thus prevented the integration of the instrument. On one side, the economic information was not powerful enough to improve the solid organisational interaction and discussions concerning employee safety improvement. On the other side, the interactions between technical and organisational barriers hindered the integration. The technical factors (e.g., the availability of health and safety information within information systems and the possibility of collecting accident information from established company reports) contributed less than the organisational barriers. The cognitive barriers were very important in opening the discussion concerning the potential improvement of employee health and safety, and to ensure that economic information did not prevail on the ethical aspects related to employees. However, empathy towards workers and the fear of potential new injuries expressed by the health and safety unit staff enabled the implementation but not the integration, because the same attitude towards the promotion of employee safety through a new instrument was not diffused within the organisation, thus representing a cognitive and organisational challenge. The health and safety unit appeared fragile and, due to a lack of organisational charisma and power, unable to design and promote the definitive steps necessary for integration (see also Hasle and Jensen, 2006).

Latium - The (no)-integration phase

A one-day meeting was also organised at Latium more than a year after the end of the experimental implementation to understand whether and how the integration had occurred. Some steps had been made to share the instrument at an organisational level. The activities map related to the accidents was the object of specific training initiatives for the operational level employees to illustrate the organisational effects of an accident. Although the economic information was not presented, the map was considered an improvement in the process of measuring health and safety performance. During the year, a cost center was also created within the accounting information system to collect monetary information related to health and safety aspects. However, the health and safety unit at Latium made fewer efforts to adopt and integrate the instrument than the unit at Marche. A first organisational barrier that emerged was the non-prioritisation of the project despite the positive results achieved during the implementation phase. Between 2012 and 2013, the health and safety office concentrated its analysis on waste management services, which changed progressively from a mixed system of collection (automatic and door to door collection), to a complete door to door collection system. This change implied a re-organisation of employees' jobs,

and also an analysis of the implications of such change on employees' safety due to the advanced average age of the workforce. The buyer process concerning safety equipment was also changed to reduce the costs of equipment and to increase the delivery aspects. These activities, in addition to ordinary activities, did not allow time to be dedicated to stabilising the implementation phase and to promoting the integration phase. In addition, it underlined the difficulty of maintaining sufficient attention on the new instrument within the company.

Other obstacles were also present. The general director did not consider the idea of promoting economic literacy on employee safety to be relevant. The experimentation and results of the project were presented to the general director in a specific private meeting managed by the health and safety manager with the presence of the health and safety unit. The general director recognised it was important but not sufficiently relevant to promote its diffusion. According to the health and safety manager, the general director considered the low number of accidents reported over the years to be a sufficient indication of the company's good health and safety performance and of the effectiveness of the existing activities, without the need to commit further resources to develop other tools. In fact, Latium's performance safety indices were better than the national statistics for the sector. As a consequence of the general director's decision, the health and safety unit observed that the human resource manager preferred to stop the full implementation of the tool. A further obstacle was the company's general approach to health and a safety issue, which was normatively, oriented despite the incoming OHSAS 18001. The instruments adopted over time to manage and measure good health and safety performance were coherent with the legal framework's requirements, with a low predisposition towards the adoption and integration of new and voluntary tools with tested and proven effectiveness. The organisational climate concerning the adoption of a new tool was thus not open, hindering the exploitation of the instrument.

The health and safety office also missed an opportunity to promote the collection of the monetary information on accidents in the procedure for analysing non-conformities within the on-going OHSAS 18001 system. OHSAS 18001 implementation might have represented an important moment to change specific procedures and to involve different units in the data collection process. However, the health and safety unit did not consider such a possibility, even though it had already been discussed in the previous meeting, thus missing the opportunity to reduce the technical difficulties concerning data collection with the operational and human resource units. At an organisational level, the administrative unit responsible for book keeping and financial accounting analysis did not given any attention to safety aspects. The absence of an organisational awareness-raising process was also detrimental. The project was officially managed by the human resource office, developed by the health and safety unit, not shared with the general director from the beginning and based on the occasional and temporary involvement of the technical-operational unit.

During the last meeting, the health and safety team revealed that its conservative approach towards the integration of the new tool and the related exploitation of the accident cost analysis had stopped the project, and also noted the difficulties of learning from the information and demonstrating its valued added by sharing the importance of the information within the organisation. The presence and mix of technical, organisational and cognitive factors inhibited the integration of the instrument, which after the initial enthusiasm and the supporting phase managed by the research team was considered of minor importance, only transitory and not sponsored within the organisation. Latium appeared to be 'paralysed' by the health and safety unit, unwilling to foster the instrument integration due to the efforts involved in abandoning a comfortable, routinized and well-known approach to measuring employee health and safety performance.

5. Discussion and conclusions

The aim of the study was to analyse the implementation and integration of an accounting instrument related to employee health and safety, providing evidence to discuss whether and how the instrument was able to support employee health and safety decision making. The analytical

framework revealed different technical, organisational and cognitive barriers related to the implementation and integration of the instrument that was implemented, yet weakly integrated and eventually abandoned by the two companies. The instrument, when adopted, supported employee health and safety decisions, even though the link between economic information and employee safety was uncertain and the learning aspects related to the use of the information were fragile. The failure of the integration was not due to the inadequacy of the instrument per se, but to the ineffective management of the integration. While the study provided evidence of the instrument's conceptual relevance (Mättö and Sippola, 2016), the integration phase was not managed with the consistency, skill and care required to achieve its expected benefits by the various organisational members, indicating a common pitfall (Klein and Knight, 2005).

The failure to move from implementation to integration underlined the importance of the organisational climate as a core factor in fostering integration, despite the perception that employee health and safety provides meta-value for organisations (Bouten and Hoozée, 2016). In Marche there was greater participation in and discussion of the project, evidencing a more positive organisational climate, whereas in Latium the status quo dominated, as indicated by the health and safety manager stopping the instrument implementation when he perceived the necessity of involving other areas in the data collection process to ensure complete and reliable information. The findings reveal that even though technical barriers were present, they were less problematic than the organisational barriers, thus highlighting some differences compared with previous studies in which the role of data collection was emphasised (Gosselin 2007; Ibarrondo-Davila *et al.*, 2015). The interplay between the two technical and organisational dimensions also hindered the integration phase, suggesting a dynamic relationship between the two.

Cognitive factors played a fundamental role in shaping the development process. The moral stance of the health and safety units favoured the project playing a critical role. The idea of further improving employee safety conditions through the experimentation and application of the new instrument was a strong cognitive enabler. This condition was particularly evident in Marche, while in Latium the weak efforts towards instrument integration inhibited the activation of colonising mechanisms at an organisational level. In the case of Latium, a certain difficulty in fully interpreting and using the information derived from the instrument hindered the creation of a clear link between the instrument and health and safety performance assessment, thus increasing the hesitancy towards promoting organisational efforts. In Marche, the passionate commitment of the health and safety unit and their cognitive openness towards accepting and experimenting around the theme of employee health and safety versus economic analyses helped to start the integration phase, but was eventually insufficient to overcome the organisational barriers. In the case of Latium, the interplay between a low cognitive propensity to experiment with the instrument's potential and organisational inertia stopped the process at the implementation phase. The evidence from Latium adds empirical weight to the theoretical argument of Hahn *et al.* (2014), according to which individual managers or employees may prefer to continue with traditional forms of analysis and decision making in cases of high uncertainty related to social (and environmental) issues. In revealing these findings, this study informs the accounting development process literature by providing the first empirical explanation of the impact that cognitive aspects have on opening up and closing down the possibility of accounting to improve employee safety decisions. The analysis of cognitive factors indicates the critical fit between the mind-set of the organisational actors and decisions at work. The accident cost analysis tool was adopted, even if only temporarily, because it shared and enhanced the importance of employee health and safety. This analysis suggests that the instrument acted as a mediating instrument: it created a space for considering cost-saving experiments and simultaneously addressed the wider issues around employee health and safety improvements.

At a theoretical level, the cases analysis suggests that integrating an accounting instrument within an organisation (considered as a social system) may require the concurrent presence of technical, organisational and cognitive enablers. The concurrent activation of different enablers is critical when the new instrument represents a strong, even radical, change from the routinized way

of thinking and acting on a certain topic (Fraser, 2012), as the case analyses revealed. The activation of organisational mechanisms concerning the new instrument (organisational dimension) requires the instrument to be understood by different areas of the organisation, the activation of individual and organisational learning mechanisms (cognitive dimension) and the modification of technical aspects (technical dimension). The three dimensions are interdependent and may constitute a unified whole. This argumentation is different from that of Gond *et al.* (2012), according to which integration can also occur when one of the dimensions is more developed than the others, and thus is able to push and drive the others towards integration.

The findings promote the idea of an order of importance among the enabling factors, which represents the epistemic contribution of this interventionist research (Lukka and Soumala, 2014). The order of importance reflects a level of proximity, in figurative terms, of the three dimensions of enablers of employee safety. The emotions related to the cognitive aspects of employee health and safety were the most important enablers, followed by the organisational and the technical factors. This tentative establishment of an order of importance indicates that each dimension may stimulate employee health and safety related decisions in different ways. In the two case companies, the idea of further reducing accidents using a new instrument primarily influenced the cognitive dimension, and was then objectivised and translated, despite several difficulties, into organisational and technical managerial aspects. Accordingly, while the integration of a certain instrument may be achieved when the three dimensions of enablers are concurrently activated, the study revealed that the cognitive dimension was the most important in the case of employee health and safety. This means that the presence of cognitive enablers represented the initial condition upon which the other dimensions could be developed. The idea of an order of importance between enablers represents a venue to further discuss how the implementation and integration of a certain instrument can take place (Ditillo and Lisi, 2016) in the presence of multiple and interrelated factors. Similarly, an order of importance may also exist between the hindering factors, as indicated by the central role played by the organisational dimension in the cases analysed. The barriers were related to an inadequate change in the management processes (i.e. data collection process, coordination and shared responsibility) and management techniques (accident report analysis and safety certifications) related to the new accounting instrument (see also Hoque and Halam, 1999). The order of importance may also depend on the type of instrument analysed. McLean *et al.* (2016), for example, indicated the critical importance of technical factors in studying the development and abandonment of the EVA^{TM}.

From a societal (phronesis) perspective (Lukka and Soumala, 2014), the research provides evidence of the fragility of evaluating employee health and safety using economic information. As revealed, even if accounting instruments can contribute to the creation of a healthier workplace, the ethical dimension should always prevail when employee health and safety aspects are evaluated. While economic analyses represent a shared language within organisations, in the case of health and safety matters they should be accurately defined to avoid misleading effects. Accordingly, the promotion of a win-win safety logic at the institutional and policy level (EU-OSHA, 2010; ISSA 2013) may risk producing counter effects if there is a failure to stress the notable importance of the ethical dimension of employee safety. This point may support the debate among institutions and regulators concerning ways to enhance and stimulate employee health and safety issues at an organisational level.

The research is subject to a number of limitations. The findings are inevitably tied to the social and organisational context in which they emerged. In addition, despite the strategies employed to promote the ethical perspective during the case analyses, some potential biases, such as the selective interpretation of information, may be present due to the subjectivity of the analyses. While the findings of the study move forward the debate on accounting for employee health and safety, there remains a worrying lack of knowledge of what it actually means to practise accounting in this field and how other types of accounting and counter-accounting represent this setting. Future research avenues can continue to analyse the interplay between the three dimensions of factors and how they impact, singularly or collectively, on the implementation and integration of certain accounting

instruments. In particular, the analysis of compatibility between organisational culture and the values and beliefs embedded in accounting instruments related to employee health and safety could be an interesting avenue to study safety accounting innovation. The level of adoption, the difficulties of implementation and integration, as well as the organisational and social meanings of different safety accounting instruments such as safety performance indicators, accident cost analysis tools, budget and investment criteria for health and safety management could be also investigated.

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The supply chain in the context of Industry 4.0: a qualitative analysis

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Abstract

Objectives. *This paper seeks to identify an ideal contract for supply chain coordination, in the context of Industry 4.0. It uses a dyadic approach of adopting a contract as a mechanism for supply chain coordination. Contracts can be implemented for coordinating the supply chain by means of increasing both the company's performance and the suppliers' capabilities in the context of Industry 4.0 while keeping an eye on sustainability.*

Methodology. *Because this is an explorative study, it applies a comparative case study on three companies operating in the Netherlands, belonging to the trailer industry, and applying the industry 4.0 paradigms and sustainable practice.*

Findings. *The results show that the ideal contract involves different balanced scorecard factors and supplier capabilities..*

Research limits. *This research focuses on one specific industry as well as to one country. Future research can replicate this research design to other sectors as well as other countries*

Practical implications. *Practitioners, approaching to the Industry 4.0 in a sustainable way, can use this study as a reference to choose contracts to coordinate the supply chain.*

Originality of the study. *This paper adopts a dual research approach by combining the balanced scorecard theory with the supplier capabilities theory. This combination creates a better understanding of the driving motivations for implementing contracts in the context of Industry 4.0 and sustainability.*

Keywords: *Balance scorecard; industry 4.0; supply chain contract; sustainability; supply chain coordination*

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1. Introduction

The fourth industrial revolution, referred to as Industry 4.0 and also known as "smart manufacturing", "industrial internet" or "integrated industry", is currently transforming the entire Supply Chain (SC) (Dallasega et al, 2018). The Industry 4.0's potential consists of forecasting some main effects of new technologies into industrial production, supply chains, business models and business processes (Schmidt *et al.*, 2015; PlatformI4.0, 2015). A supply chain is a system of interdependent organizations manifesting the flow of physical goods and information (Chen and Paulraj 2004), which is also involved in the theme of green adoption and sustainability (De Giovanni and Esposito Vinzi, 2014a). The subject of the supply chain by definition is not a single company but it is entire structure, which can be: a serial structure, convergence structure, divergent structure and a network structure (Miemczyk *et al.*, 2012). Therefore, Industry 4.0 considerably modifies the relationships among SC members, their joint decision-making process as well as the common actions and goals (Simatupang *et al.*, 2002). This urgency emerges even more in the recent view of sustainability, which imposes firms to develop sustainable solutions within the firms' network (De Giovanni and Esposito Vinzi, 2014b)

We seek to contribute the SC coordination literature, which consists of several mechanisms for sharing the benefits and the risks of jointly manage the flows of good, information and money. Most the existing studies primarily on theoretical research mainly game-theory oriented (read De Giovanni and Zaccour (2019) for a recent survey) while neglecting the analysis in real business.

This is an explorative study. It applies a comparative case study on three companies operating in the Netherlands, belonging to the trailer industry, and applying the Industry 4.0 technologies. The paper is organized as follows: the second section presents a literature review on supply chain contracts, on balanced scorecard theory, and on supplier capabilities theory. The third section focuses on methodology and research design; The fourth section specifies the outcomes of the empirical analysis. Then, it proposes a discussion on the ideal contract for the industry. Conclusions, limitations of the study and suggestions for further research are remitted to the last section.

Thus, this research explores the use of contracts to achieve supply chain coordination when companies invest in Industry 4.0 technologies (Huang et al., 2003). It introduces contracts as mechanisms for increasing company's performance. Furthermore, this paper uses the balanced scorecard theory to identify the factors encouraging supply chain members to choose a specific contract, within the context of Industry 4.0 and sustainability. Finally, this study use contracts based on suppliers' capabilities (Ruuska *et al.*, 2013), in order to generate a sustainable supply chain in terms of long-term operational efficiency.

2. Literature Review

2.1 Supply Chain Coordination with Contracts

A coordinated supply chain can be defined as the cooperation between two or more companies to plan and execute operations through ad-hoc mechanisms with greater success than without collaboration (De Giovanni, 2014a,b).

Several types of contracts can coordinate the SC. This paper focuses on the trailer industry, which can be categorized as a make-to-order (MTO) industry. An MTO company has the following characteristics: a product mix with a few standard products; a flexible workforce; volatile demand that cannot easily be predicted; production planning that cannot be planned in advance; critical product lead times and price agreements before the production starts. The work by De Giovanni and Zaccour (2019) identify the most suitable coordination mechanisms in sustainable supply chains: buy-back, quantity-flexibility, revenue-sharing and sales rebate contracts. These four contracts

represent the fundamental contracting literature for this study and for the specific application on the trailer industry.

The first contract that we explore is a *buy-back contract*, which specifies the agreement of a supplier to buy back unsold goods from the buyer at an agreed-upon price. When the buyer implements a *quantity-flexibility contract*, the supplier provides a full refund for unsold items as long as the quantity is not larger than the agreed-upon quantity. The *revenue-sharing contract* involves an agreement where the buyer shares its revenues with the supplier in return for a discount on the wholesale price (De Giovanni and Esposito Vinzi, 2014a,b). In this way, the contract ensures the selection of optimal order quantities for both parties (Kanda and Deshmukh, 2008). The *sales rebate contract* implies the payment of a rebate by the supplier for any item sold by the buyer above an agreed-upon quantity. This will lead to incentives for the buyer to increase sales to meet sales targets. The seller must offer "scan back" rebate programs in order to ensure that the rebate is paid based on actual sales (Prekker and De Giovanni, 2019). Multiple forms of such "scan back" rebates exist. Besides the four MTO contracts, a *composite contract* can be implemented to coordinate the supply chain. A composite contract specifies a combination of two (or more) contracts (De Giovanni and Zaccour, 2019). Xiong *et al.* (2011) propose a composite contract which combines the buy-back contract and the quantity-flexibility contract. This contract allows the buyer to return unsold products up to a maximum quantity with a full refund. The seller buys back the remaining unsold products (above the maximum quantity) at a buy-back price. The composite contract has some advantages in relation to the buy-back and quantity-flexibility contract in terms of SC coordination and profit allocation between SC members. Moreover, the composite contract can be more flexible than the buy-back and quantity-flexibility contracts in terms of risk allocation over the SC.

2.2 Company Performance from the Balanced Scorecard Perspective

The first goal of coordinating the supply chain with contracts entails the improvement of individual company performance. Kaplan and Norton (1992) introduce the balanced scorecard theory, which includes "*a set of measures that gives top managers a fast but comprehensive view of the business".* The balanced scorecard theory specifies four perspectives, which can be defined by using two types of measures: financial and operational performance (Kaplan and Norton, 1996, 2001, 2009; Brewer, 2000). The former identifies the financial perspective of the company, while the latter links to customer perspective, internal business process perspective, as well as learning and growth perspectives.

The use of contracts as a mechanism to coordinate the supply chain has not yet been studied in combination with the balanced scorecard theory. In this research, the balanced scorecard theory demonstrates the importance of the different performance measures. We use the list by Bhagwat and Sharma (2007) as a checklist for studying the reasons why SC members implement some contracts.

2.3 Supplier Capabilities

The second goal of coordinating the SC with contracts aims at improving supplier capabilities. To analyze the supplier's capabilities, our research elaborates on the supplier capabilities theory proposed by Ruuska *et al.,* (2013). This theory makes a distinction between three types of capabilities: technical and operational; relational; and developmental capabilities. Technical and operational capabilities relate to the company's technical, economic and delivery capabilities to manage the administration, design, distribution and service operations (Ruuska *et al.,* 2013). Furthermore, these types of capabilities may include operations management elements, such as: inventory management, quality, time, flexibility and inventory. Finally, new balance scorecard structures should also contain information regarding the environmental performance, link them to

the operational impact and highlight the economic implications (De Giovanni and Esposito Vinzi, 2014a)

Relational capabilities, or interaction capabilities, refer to the suppliers' relationship development process (Möller and Törrönen, 2003). The article by Johnsen and Ford (2006) identifies four distinct subcategories within the interaction capabilities. The first subcategory is a human interaction capability, which embraces the workers' knowledge and skills. The second is the technological interaction capability, which contains the workers' knowledge from multiple sources. The managerial systems interaction capability is the third category and refers to knowledge creation and control. Finally, the last subcategory consists of the cultural interaction capability, which relates to the workers' knowledge content and structure .

Developmental (or innovation) capabilities refer to relationships with suppliers as part of the company's innovation process (Lanza and Passarelli, 2014). Some examples are: the ability to design new products, the willingness to use technological capabilities, and the willingness to share key technological information (Krause *et al.*, 2001). Furthermore, the impact of the supplier's innovations on the buyer's performance is significantly greater when the buyer has an incentive to learn and use external knowledge.

Improving the supplier's capabilities can be vital for supply chain coordination because firms seek to only coordinate with highly-performing partners. This becomes especially true when investments in Industry 4.0 technologies are evaluated. The integration of some technologies within the supply chain is far from being easy. For example, the adoption of *Clouds* can only happen when all supply chain members are well connected through a supply chain tour that works with high speed and stable connections. *Automated Guided Vehicles* help to improve the logistics performance only if all suppliers are connected with them and adjust the supply chain decisions accordingly. The adoption of *3D printing* requires a new balance between the manufacturers' production capacity and the supply chain requirements, with the purpose of synchronizing the product flow. *Internet of things* requires that all supply chain partners invest in this technology to gain all related advantages. *Robotics* creates high efficiency in some parts of the supply chain that needs to be shared and integrated with other supply chain tiers. The use of *Artificial Intelligence* systems helps only if all supply chain partners share the information and connect with this technology. On the top of that, firms should select their Industry 4.0 technology portfolio while also optimizing the environmental performance. Therefore, the selection of technologies and green solutions should be led together during the identification, adoption and implementation of contracts (see Kiel and Muller (2017) for a comprehensive discussion).

3. Research design and Methodology

Starting from the existing literature the first research question of this study is the following: *Which types of contracts exist in the trailer industry to coordinate the supply chain dealing with Industry 4.0 investments and sustainability?*

This paper presents a comparative case study on three Dutch companies[1], belonging to the trailer industry. The Netherlands is one of the most active European countries in the Industry 4.0 initiatives. The I-com's Report 2017, proposes a "*synthetic index on the level of preparedness for Industry 4.0 in different EU countries. Finland tops the ranking, with a score of 100 - thanks primarily to the adoption of certain technologies (cloud computing services and Big Data analysis tools) and the relatively high level of employment of both ICT specialists and data workers - being the country at forefront of the fourth industrial revolution. The Netherlands, Germany and Denmark immediately follow*". This is also due to some specific public policies. On 19 April 2016, in fact, the European Commission launched the first industry related initiative of the Digital Single market package (https://ec.europa.eu/digital-single-market/en/policies/digitising-european-industry) aimed

[1] They are labeled A, B,C because, they asked to be anonymous

at building on and complementing the various national initiatives for digitizing industry, such as *Industrie 4.0* in Germany, *Smart Industry* in the Netherlands and *l'Industrie du future in France, Industria 4.0 in Italy*. These projects aim at reinforcing the EU's competitiveness in digital technologies and ensuring that all European firms can increase the performance through the use of digital innovations while always keeping an eye on sustainability.

Within the Dutch program, Smart Industry is the action program run by the employers federation for the technology industry (FME) , the Ministry of Economic Affairs, the Chamber of Commerce, Netherlands-ICT (sector federation for ICT) and TNO. It is a three-year program (2015-2017) that was launched after a year preparation. "*Smart Industry should be a cross-cutting theme within the top sector policy in which a broad coalition of companies, knowledge institutions and government should be involved*" (Larosse, 2017, p.10). It was an opportunity to concrete Action Agenda that has the aim to make the industry more competitive through faster and better application of technologies, and thus foster growth and jobs. This Action Agenda contains 15 actions under three action lines: the Action line 1 focuses on the capitalization of existing knowledge (mainly through awareness creation); the Action line 2 regards the acceleration of Field Labs (the main and most innovative action) and is run by TNO and the Ministry. The Action line 3 concerns the Strengthening the foundation (knowledge, skills, ICT parameters). These actions are run respectively by TNO, FME and Netherlands-ICT. A Smart Industry field-lab is an operational industrial environment where Smart Industry innovation and technologies are developed, tested and/or implemented and where also people learn how to apply the new technologies. Smart Industry Field Labs (www.smartindustry.nl) focus on their own radical innovation and have defined a program of three year or more that consists of multiple innovation and education/training projects. It has in general one physical location and it has a field-lab program coordinator.

We focus on the *Field lab Flexible Manufacturing* that aims at improving the production processes flexibility through robotics, ICT and operator support systems. Faster changeovers and zero programming allow a large product mix to be manufactured in small series more easily and flexibly and with zero defects. By analyzing this Field Lab, over a sample of 102 involved firms, we selected 3 companies connected one each other and belonging to the trailer supply chain. These 3 firms introduced different enabling technologies (precisely: additive manufacturing and big data). We have chosen the trailer sector because it is considered the one where the Industry 4.0 is having the most important impacts in terms of growth. The trailers are generally an unpowered vehicle towed by a powered vehicle that is mostly used for the transport of goods and materials. The worldwide market for trailers is huge. The Business Research Company valued it at €25.3 billion in 2017. Asia-Pacific is the largest geographic region accounting for $9.8 billion of that total and China the leading country buying $5.1 billion worth of trailers. Europe is also a major trailer market with trailer registrations exceeding 190,000 in Western Europe in 2017. In Western Europe, production grew at a compound annual growth rate (CAGR) of 6% between 2012 and 2017 based on 180,000 trailers manufactured in 2012. It predicts that the CAGR will be 1% between 2017 and 2021 with 230,000 trailers produced in 2017. For Eastern Europe, Roland Berger estimated that production had grown by CAGR of 3% from 2012 to 2017 and forecasts a 0% CAGR from 2017 to 2021 (Roland Berger Market study, 2018).

According to Eisenhardt (1989), a case study is "*a research strategy which focuses on understanding the dynamics present within a single setting*". A case study aims to provide descriptions, test theory or generate theory. Case studies can combine several data collection methods, such as interviews, archives, questionnaires and observations (Eisenhardt, 1989). A (comparative) case study can be seen as a qualitative method which is useful for understanding the relationships in underlying (quantitative) theory (Eisenhardt, 1989). It is an appropriate method, since this study intends to fulfill the literature gap of applying contracts in a practical situation.

This study uses multiple data collection methods (Eisenhardt, 1989), such as semi-structured interviews, documents and web site information. Semi-structured interviews can be used when the researcher wants to cover main topics and go into greater detail on a topic in a structured way (Harrell and Bradley, 2009). Ten questions cover the main research goals of this study (Appendix

I), with the effort to understand why contracts are implemented. The second data source of this study entails documentation and information from firms' websites.

Selecting an appropriate method is critical for the success of the study. This paper uses the method of within-case analysis, coupled with a cross-case search for patterns. Within-case analysis can be seen as write-ups for each case, in order to gain insight into the data and cross-case search for patterns (Eisenhardt, 1989). A tactic to search for cross-case patterns can be the selection of dimensions and the search for within-group similarities and intergroup differences (Eisenhardt, 1989). The within-case analysis with cross-case search for patterns can be seen as an appropriate method for data analysis, since this study intends to compare data in order to find similarities and/or differences among cases. According to Eisenhardt (1989) "Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process". In this study, the process of analyzing data began with the selection of the companies.

The three companies we selected are all manufacturers of trailer parts and/or final products and all participate the Smart Industry initiative in the Netherlands.

Company A is a high-tech, leading company in the metalworking chain. It develops, produces and assembles sheet metal parts, welding structures or modules, and fully assembled products and/or modules. Company B has a leading position in the design and production of trailers for abnormal road transport. Company C produces trailer parts. Furthermore, Companies A and B cooperate, because Company A assembles certain modules for Company B. The interviews took place between September and December of 2017. The main goals of the interviews were to gain insight into the existing contracts. Data and information were gathered through interviews and participation in meetings with individuals within the firms as well as with industry experts from main European trailer companies and editors of industry magazines. In particular, we carried out 3 personal interviews (6 hours) with industry experts and editors of industry magazines; moreover, the research team conducted personal interviews and participated in meetings with members of firms for a total of 20 hours. In particular, the team interviewed the operations managers, the marketing managers, some engineers involved in the R&D activities and the CEOs .

As documentation provides an essential foundation for research designs (Yin 1994), the state of the art of products and technological innovations and advancements in the trailer industry was established by examining reports in the most important trade publications. Data from the interviews provided an understanding of expected developments especially in terms of innovation performance; these data were also used to identify what kind of product new products and new processes could be conceived of as enabling technology applications. Data from interviews were also supported by conference announcements, proceedings, and various other public documents that supplied information about product and process specifications, performance, and expected benefits of Industry 4.0.

Interviews typically lasted from 1 to 3 hours, were audio-recorded, transcribed separately by all the authors, and subsequently compared. Most of the participants were interviewed twice, and data collection was interrupted when theoretical saturation was reached (i.e., additional interviews contributed only minimal and redundant understanding (Strauss 1987). To conceptualize our findings, we analyzed the content of data and information provided by the interviews, because this represents the most frequently adopted method for using empirical data collected through case studies (Yin 1994). We then proceeded through several cycles of data versus theory confrontation, with each cycle providing novel insights, novel data, and emergent concepts and theories. To complete the understanding obtained through the case method, an exercise book was kept that gathered memos, reflections, and an ongoing diary of research advancements, descriptions of activities, and processes noted by the field researchers. This approach to theory extension, carried out through continuous iterations between data, literature, and emergent concepts and theories, is widely used in qualitative research (Eisenhardt 1989). Field data were examined by all the researchers of the group who individually drew up briefs and notes regarding research questions of interest. These notes and documentations were subsequently grouped into memos according to either their content or a specific information category. Individual memos were then continuously

matched and compared so as to assess whether, and to what extent, various interpretations were triangulating together to explain the field data (Eisenhardt 1989). Once we conducted the matching of memos, they were grouped into conceptual clusters representing analytical ideas that were deemed highly related (Danneels 2007). These conceptual clusters were used to organize and interpret the empirical findings. Finally, in order to refine and validate our findings, our interpretations were presented at a meeting at the three firms for an internal-member check during which comments and feedback were collected to further refine our insights.

4. Results

The results of this study demonstrate that few similarities exist between the contracts used in the trailer industry and the contracts described in the literature. None of the contracts can be categorized within the contracting literature. Due to these differences, it will be interesting to investigate which types of contracts exist in a practical situation.

From data processing, it comes out that Company A uses four different contracts based on different product groups. The company categorizes product groups and contracts based on the Kraljic matrix, where the vertical axis specifies the financial impact of the products, while the horizontal axis shows the risk of product supply. Typically, when a product has a high supply risk, this means that many other firms can offer the product. Company A's first contract is the *"call amount"* (CA); it specifies an agreement for buying a fixed quantity in an unspecified period of time. This contract allows the company to reduce the amount of inventory over the supply chain (De Giovanni et al., 2019) and reduce the emissions. This means that Company A has a duty to call an agreed-upon amount of products within a period of time which has not been specified in the contract. Company A can call this amount any time it needs it. This contract can be seen as Company A's most basic contract. Company A has a contract with the supplier for buying a fixed amount (x) only when they need the axles. In this way, the supplier ensures the availability of the agreed-upon fixed quantity. Therefore, Company A does not need to store axles in its own warehouse. The CA contract applies to few products of Company A in a narrow market with few possible suppliers.

The second typology of contract is the *"call time"* (CT) contract; it entails an agreement for ordering a large quantity in a fixed period of time. Company A uses this contract for multiple product groups, and it applies especially to products with a low financial impact. The third contract is the *"framework contract time"* (FCT). With this contract, Company A and the supplier agreed to buy a certain quantity in a fixed period of time. The framework contract has many similarities with the call time contract, except for the longer term and for the forecasted prices of the supplier. The main reason for implementing this contract is related to the risk sharing and the administrative costs with the supplier. Company A uses this framework contract, for example, with a supplier of cylinders situated in Korea. They made a deal that the supplier always guarantees that it will have enough cylinders on inventory. When Company A orders a product, the supplier immediately delivers the product within a five-week lead time. However, Company A needs to buy the remainder products when Company A decides to stop buying the cylinders from the supplier. In this way, Company A focuses on product availability. Additional to this contract, it becomes necessary to build a relationship with the supplier. Both parties need to trust each other before signing this contract. The use of Industry 4.0 technologies can substantially help in this framework through a higher level of information sharing.

Company As' last contract entails a *"composite contract of the call amount and call time contract"* (CAT). This contract specifies to buy a fixed quantity every time an order must be placed. Company A uses this contract for products in an unpredictable market: for example, the steel market. The supplier delivers the steel in coils of 25 tons with a lead time of one week. However, Company A needs approximately 30 tons each month, which means that it has to order multiple times each month. This implies that Company A needs to check the inventory each week. The company buys a coil of 25 tons when the inventory falls below a certain calculated level. In this

way, they always receive a fixed quantity while the time for ordering varies. The technologies industry 4.0 can help to identify the best time for emitting the order as well as reduce the traffic congestion; thus, it also becomes a lever to improve the environmental performance.

Company B's first contract entails the *"standard supplier agreement"* (SSA). The purpose of this contract aims at mitigating risks. Company B uses the SSA for strategic products. The SSA can contain several specific agreements for different products. For example, when Company B buys tires for trailers, it uses a call contract. They agree with the supplier to buy a certain amount of tires. When they actually need less than agreed upon, Company B has to pay a penalty, and when they actually need more, they will receive a bonus.

The second contract of Company B is the *"service level agreement"* (SLA). An SLA specifies the agreed-upon performance of the supplier and certain duties after the purchase. An example of an addition in the SLA contract could be the possibility of using a buy-back option for nuts and bolts. Bolts and nuts can be seen as routine products, and it is therefore hard to measure how many goods Company B will need for a certain period. The buy-back contract, specified in the literature, could be an option to cover this problem. The manager did not use this option before the interview. However, the manager is considering this option for adding it to the SLA after the interview.

Company C uses a *"supplier manual with framework or call contract"* (SMFC) as its fundamental contract. It contains a basic contract which can hold multiple additional agreements, such as a framework or call contract. These additional agreements vary based on the different product groups. The identification of a unique contract for each product category becomes extremely difficult due to numerous market variations. Therefore, the details of the contract differ significantly among the product groups.

Company Performance

Table 1 summarizes which aspects are seen by each firm as the main purposes for implementing a contract, while Table 2 shows, for each contract, the ranking of the balanced scorecard perspectives in order to determine which perspectives can be seen as the most preferred goal of implementing the contract (in the rankings, 1 is the most preferred). As an example, the financial perspective describes the most important measure for Company A's CA contract.

Tab. 1: Aspects from Balanced Scorecard Perspectives

Company	Contract	Financial Perspective	Customer Perspective	Internal Business Perspective	Learning and Growth Perspective
A	CA	Rate of ROI Delivery performance Supplier cost saving initiatives	Delivery lead time Delivery performance Quality of delivered goods	Total inventory cost Planned process cycle time Total cash flow time	Supplier ability to respond to quality problems Accuracy of forecasting techniques Customer perceived value
	CT	Delivery performance Delivery reliability	Delivery lead time Quality of delivered goods	Supplier lead times against industry norms Accuracy of forecasting techniques Total inventory cost	Supplier cost saving initiatives Order entry methods Range of products and services
	FCT	Buyer-supplier partnership level Delivery reliability	Buyer-supplier partnership level Order lead time Range of products and services	Supplier lead times against industry norms Accuracy of forecasting techniques Purchase order cycle time	Supplier assistance in solving technical problems Supplier ability to respond to quality problems Buyer-supplier partnership level
	CAT	Information carrying cost Delivery reliability	Delivery lead time Quality of delivered goods	Total supply chain cycle time Level of suppliers' defect free deliveries Total inventory cost	Supplier assistance in solving technical problems Flexibility of service systems to meet particular customer needs Customer perceived value
B	SSA	Net profit vs productivity ratio Rate of ROI Supplier cost saving initiatives	Flexibility of service systems to meet customer needs Delivery lead time Delivery reliability	Total cash flow time Level of suppliers' defect free deliveries Product development cycle time	Supplier assistance in solving technical problems Supplier ability to respond to quality problems Supplier cost saving initiatives
	SLA	Net profit vs productivity ratio Budget variations Supplier cost saving initiatives	Order lead time Flexibility of service systems to meet customer needs Delivery reliability	Total supply chain cycle time Accuracy of forecasting techniques Total inventory cost	Supplier ability to respond to quality problems Supplier cost saving initiatives Capacity utilization
C	SMFC	Delivery reliability Supplier cost saving initiatives	Buyer-supplier partnership level	Total inventory cost	Buyer-supplier partnership level

Source: Our elaboration

Tab. 2: Ranking Balanced scorecard Perspectives

Company	Contract	Financial Perspective	Customer Perspective	Internal Business Perspective	Learning and Growth Perspective
A	CA	1	4	3	2
	CT	3	4	2	1
	FCT	1	2	4	3
	CAT	2	1	3	4
B	SSA	3	1	2	4
	SLA	1	3	4	2
C	SMFC	1	2	3	4

Source: Our elaboration

From the interviews it is revealed, for example, that within the financial perspective of the balanced scorecard, delivery reliability can be seen as a highly valued aspect which companies prefer more often than other financial aspects for multiple contracts. Other financial aspects which relate more to supplier capabilities can be, for example: delivery performance, buyer-supplier partnership level, and supplier cost-saving initiatives. This implies that the companies in the sector focus more on directly enhancing supplier capabilities rather than focusing on financial goals. Therefore, the companies focus not directly on financial aspects; rather, they want to ensure that the products are of high quality in combination with on-time delivery. Actually, this result conflicts with the contracting literature, because most contracts in the literature focus directly on profit optimization rather than supplier capabilities.

Within the customer perspective, "supplier capability" aspects can also be seen as preferred aspects. Managers used to focus almost exclusively on product quality, moreover, within the trailer industry, product quality can be seen as a fundamental base before producing trailers and/or parts to reach, in the end, a high customer satisfaction level. Furthermore, flexibility of service systems to meet customer needs is identified as a highly valued aspect within Company B's contracts. Company B's and Company A's customer order decoupling point can typically be seen as engineered to order (Sharman, 1984). The customer places an order at Company B to engineer a customized trailer with specific requirements. Most trailers built at Company B can be seen as engineered to order, which means that each trailer has its own purposes. Therefore, it implies that the sector must have a supplier that must be flexible in delivering services/products to cover the differences in customer needs.

Within the internal business perspective, the reduction of the total inventory costs is considered a key factor. The trailer parts on stock involve in general large products that take up much space (steel, axles, tires etc.). Therefore, reducing inventory can lead to high storage/cost savings for the companies in the trailer industry. Accuracy of forecasting techniques may also be necessary within the internal business. Company C uses forecasting agreements with some of its suppliers. This forecasting agreement involves the sharing of the suppliers' forecasting information with the trailer parts company. Furthermore, the level of suppliers' defect-free deliveries is identified several times as an internal business aspect. This aspect confirms the importance of product quality as described above.

Similar to the financial perspective, the learning and growth perspective involves multiple aspects related to supplier capabilities, such as: supplier ability to respond to quality problems, supplier cost-saving initiatives, and supplier assistance in solving technical problems. Companies in the trailer industry focus more on the development of supplier capabilities rather than their own company development; thus, they are highly dependent on their suppliers. Such companies benefit if their suppliers have a strong ability to learn and grow, while a focus on the buyer-supplier partnership level enhances strategic partnerships with suppliers for new product development. This partnership guarantees knowledge sharing between buyers and suppliers, enacting a learning process in the supply chain. The implementation of Industry 4.0 technology reinforce all these performance and allow those manufacturers to share their results and benefits with the entire supply chain.

Finally, we would mention that all these companies do not consider environmental performance within their balanced scorecard. Also, they do not formally adopt green criteria to manage their business. This evidence is due to the high pressure that firms have. Legislation imposes very tough restrictions for the manufacturers that we interviewed, resulting that environmental practices are a standard request over the supply chain, without which firms could not be a part of the supply chains that refer to the environmental practices as a compulsory policy.

Supplier Capabilities

Table 3 summarizes which supplier capabilities are seen as the main purposes for implementing a contract, while Table 4 shows the ranking of the supplier capabilities for each contract (in the rankings, 1 is the most preferred).

Tab. 3: Supplier Capabilities

Company	Contract	Technical & Operational Capabilities	Relational Capabilities	Developmental Capabilities
A	CA	Efficiency	Development of structures, strategies, & relationships, experience with collaboration	Ability to design new products or make changes in existing products
	CT	Flexibility	Customer & long term orientation, strategic alignment, top management support	Product/process improvement/innovation
	FCT	Time Availability	Understand business logic of the customer, suggestions for business improvement	Development activities, technological activities, design capabilities, product & process know-how, quality certificates
	CAT	Time Availability	Development of structures, strategies, & relationships, experience with collaboration	Product/process improvement/innovation
B	SSA	Time Quality	Willingness and ability to partner Customer & long term orientation, strategic alignment, top management support Understand business logic of the customer, suggestions for business improvement	Product improvements/innovation
	SLA	Time Quality	Willingness and ability to partner Customer & long term orientation, strategic alignment, top management support Understand business logic of the customer, suggestions for business improvement	Product improvements/innovation
C	SMFC	Quality	Trust Reliability	Product improvement/innovation R&D

Source: Our elaboration

Tab. 4: Ranking Supplier Capabilities

Company	Contract	Technical & Operational Capabilities	Relational Capabilities	Developmental Capabilities
A	CA	1	2	3
	CT	1	3	2
	FCT	1	2	3
	CAT	1	3	2
B	SSA	1	2	3
	SLA	1	2	3
C	SMFC	1	2	3

Source: Our elaboration

Product quality can be seen as a fundamental base for the production of trailers and/or parts to reach, in the end, a high customer satisfaction level. According to the supplier capabilities model, the aspect of quality can be further explained as design quality, product reliability and durability, quality conformance to specifications, and quality assurance. The companies not only focus on product quality itself, but also on the way the suppliers are coping with product quality in terms of quality conformance to specifications and quality assurance. Suppliers' capabilities related to time characteristics involve different factors, such as: delivery speed and reliability, ability to expedite a rush order, and new product development time. Company B's and Company A's goals give high importance to delivery speed due to the fact that they do not have many products in stock. The lead time of the delivery becomes extremely important to ensure that the production process will not be

delayed. Company A wants to add the aspect of product availability to technical and operational capability. Product availability relates to the time aspect in order to ensure that the production process will not be delayed. These three aspects imply for the trailer sector that companies need suppliers with a focus on product quality and availability and delivery lead time effectiveness.

All managers state that the selection process for a new supplier includes an analysis of suppliers' relational capability. This fact can be described in the supplier capability model as the "willingness and ability to partner" and "suppliers' understanding of business logic and suggestions for business improvement". Company B needs to know the suppliers' cultural values and beliefs before doing business, especially in the case of foreign suppliers. The logistic manager of the trailer company believes that trust and reliability entail the most important aspects of doing business with suppliers. Company A's manager argued that relational capability becomes more important when companies have a high partnership level. The relational capability analysis in this comparative case study implies for the trailer sector that the suppliers' relational capability can be seen as one of the main reasons for selecting a supplier and implementing a contract.

Product/process improvement can be seen as a suppliers' developmental capability, which becomes necessary for implementing a contract. This aspect relates to the relational aspect of suppliers' understanding of business logic and suggestions for business improvement. Furthermore, the learning and growth perspective describes the focus on developments of supplier capabilities rather than on a company's own development. This implies for the trailer sector that the suppliers' developmental capability cannot be neglected when implementing a specific contract. According to Company A, a fourth supplier capability must be added to the model: pricing capability. The manager states that the suppliers' ability to fairly price products becomes necessary for implementing a contract with a supplier. He states that this pricing capability becomes especially necessary for the CA and CT contracts, which have a low supply risk. A low supply risk means low product availability or a low number of suppliers (Kraljic, 1983).

Summarizing, the results of the comparative case study show that none of the theoretical contracts presented by the literature work in the trailer industry. The practical investigation also illustrates that the contracts differ among the three companies within the trailer sector.

According to Company A, firms within the trailer industry do not often use the traditional MTO contracts, because the industry can take more risks for buying and keeping products. Company A, for example, does not use the buy-back and quantity-flexibility contract,[2] and in some exceptional cases it uses the revenue-sharing contract. When suppliers have a license for certain products, they enter into agreements with the supplier to use those products in their manufacturing process while sharing the revenues. Company A also uses a sales rebate contract in exceptional cases. For example, when buying tires, the supplier asks to buy a certain specified amount of tires. When Company A actually needs and buys less tires, they must pay a penalty, and when they need more, they receive a bonus. Company B, for example, does not use buy-back, quantity-flexibility and revenue-sharing contracts.[3] Although the company has never applied a buy-back contract, it will be evaluated for buying tools, such as bolts and nuts. Company C uses the revenue-sharing contract in some exceptional cases when revenue must be shared among subsidiary companies.

One similarity between literature and practice entails the centralized strategic approach. All companies state that forming contracts in consultation with suppliers describes the best way to improve their business and coordinate the supply chain.

The results of this study demonstrate that even if the managers of the companies all recognize the contracts presented in the contracting literature, they use different contracts.

Table 5 below summarizes the different factors useful to identify an ideal contract for the trailer industry.

[2] According to the manager, companies in the retail industry use these contracts more often.
[3] The manager states that a revenue-sharing contract is typically used in the retail industry.

Tab. 5: Ideal Contract for the Trailer Industry

Positive Aspects Balanced Scorecard	**Positive Aspects Supplier Capabilities**
1. Flexibility of service systems to meet customer needs 2. Delivery reliability/performance 3. Supplier assistance in solving technical problems 4. Supplier ability to respond to quality problems 5. Supplier cost saving initiatives 6. Buyer supplier-partnership level 7. Product quality 8. Reducing inventory costs 9. Accuracy of forecasting techniques 10. Level of suppliers defect free deliveries	1. Suppliers' understanding of business logic and suggestions for business improvement 2. Willingness and ability to partner 3. Ability to expedite a rush order 4. Delivery speed & reliability 5. New product development time 6. Product availability 7. Quality conforms to specifications 8. Product/ process improvement 9. Quality assurance 10. Pricing capability

Source: Our elaboration

5. Discussion and Conclusions

The theoretical implication of this study focuses on a dual approach of combining the balanced scorecard theory and the supplier capabilities theory. The combination of investigating both theories creates a better understanding of the motivations that drive firms through the process of implementing contracts in the context of Industry 4.0 and encourage sustainability.

The results highlight different positive aspects of both the balanced scorecard theory and the supplier capabilities theory that encourage the possibility to enact a specific contract. In the firms involved in a process of Industry 4.0, the ideal contract involves the following balanced scorecard factors: delivery reliability/performance, buyer supplier-partnership level, supplier cost-saving initiatives, product quality, flexibility of service systems to meet customer needs, reduction of inventory costs, accuracy of forecasting techniques, level of suppliers' defect-free deliveries, supplier ability to respond to quality problems, and supplier assistance in solving technical problems.

Moreover, in these firms operating in the trailer sector with an Industry 4.0 approach, the positive aspects related to supplier capabilities are: quality conforms to specifications, quality assurance, delivery speed and reliability, ability to expedite a rush order, new product development time, product availability, willingness and ability to partner, suppliers' understanding of business logic and suggestions for business improvement, product/ process improvement, and pricing capability. Finally, it emerges that sustainability is a compulsory requirement for these firms and the suppliers involved within the supply chain. Therefore, all investments in Industry 4.0 should also purse environmental targets and sustainability.

The ten positive aspects from both theories have many similarities. The most positive aspects relate to both "*the quality of the products*" and "*the capabilities of the supplier*" (supplier assistance in solving technical problems, ability to respond to quality problems, cost saving initiatives, etc) encourage a supply chain thinking.

These results generate some relevant implications. Since smart Industry is about network centric approach (the end of the value chain approach), companies and organizations require a collaborative approach calling for new roles and responsibilities to be assigned to both customers and suppliers.

According to Huizinga, et al. (2015), in fact, we suggest a new customer-centric business models, both at the level of organizations and across entirely value chain. Consumers and small business could be asked to co-create in a new and complex manufacturing system (previously inhabited only by large companies). Collaboration of the parties, in fact, facilitates the circulation of knowledge and information among the players improving the product quality both in terms of technology and marketing attributes.

Moreover, the involvement of different actors in a co-creation process can help managers to better identify the environmental and social initiatives that can generate a *sustainable supply chain*. The co-creation in a supply chain model and that the new roles and responsibilities assigned to both customers and suppliers, in fact, can allow firms to apply enabling technologies to different processes, by creating different advantages. In the outbound logistics activities, for example, co-creation can generate new packaging, warehouse safety, and transportation impacts such as emissions and safety; in the operations activities can deal with emissions issues, energy use, hazardous materials, worker safety and human rights.

The outcomes of this study can be useful in more general settings, by gaining knowledge in the practical consideration of supply chain coordination through contracts. Practitioners, especially in the trailer industry, approaching to the Industry 4.0 and sustainability, can use this study as a reference for using contracts in order to coordinate the supply chain.

This research is not free of some limitations. First, it is both industry- and country-specific, as we focus only on the analysis of firms working in a trailer supply chain in the Netherlands. Therefore, several extensions may be developed while exploring these two limiting dimensions of this research. It may be interesting also to apply a quantitative analysis on a large sample of firms, across countries and industries. Future works can also focus on a longitudinal case study, by highlighting the main differences between the two periods, before and after the introduction of the Industry 4.0 approach, also focusing on the differences between a dyadic and the network approach. Moreover, a quantitative analysis on a sample of trailer firms could verify if the results are generalizable to the whole industry. Finally, different performance and supplier capability measures could be used to replicate this study.

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Appendix I Interview questions

#	**Interview questions**
1	Since you are attending the Smart Industry Initiative, which contracts are currently used?
2	Do you use different contracts for different product groups?
3	What is the main reason for implementing those contracts?
4	Are you using composite contracts?
5	If yes, do they differ among product groups?
6	Do you use one of the following contracts? a) Buy-Back b) Quantity Flexibility c) Revenue Sharing d) Sales-Rebate
7	For each contract specified in question 1: Could you rank (1-4) the importance of each of the four Balanced Scorecard perspectives?
8	For each contract specified in question 1: Could you mark two or three aspects of each perspective that are important when the specific contract is implemented?
9	For each contract specified in question 1: Could you rank (1-4) the importance of each of the three supplier capabilities?
10	For each contract specified in question 1: Could you mark two or three aspects of each capability that are important when the specific contract is implemented?

Smart Destinations: towards a more sustainable tourism industry

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Abstract

Objectives. *In general, the smart approach allows strengthening the ability to solve problems (e.g. those related to sustainability) through an efficacious use of knowledge. A smart management of tourism rests on an information-driven logic, becoming critical the capacity of organizations to capturing data from diverse sources and makes them available to managers. It is recognized that smart tourism destinations are built around a number of areas, within which sustainability is one of them. The paper intends: to present how the literature has addressed the intersection between the smart and sustainability concepts; and to display diverse cases in that intersection.*

Methodology. *The study presents a review of the literature of smart tourism and sustainability, trying to unravel the link between both concepts. Then, it performs a collection of experiences on the components of smartness, implemented with satisfactory results and aligned to the management of sustainability issues.*

Findings. *The analysis reveals several gaps that should be bridged for a full exploitation of the intersection between smartness and sustainability. Firstly, the need to move from a focus based on technology, to a more global and long-term perspective on how the data-driven logic of smartness can help to tackle sustainability issues in destinations. Secondly, the smart tourism approach has a potential for the preservation of local heritage, way of living and culture, connecting its capabilities with the social components of smart people, smart mobility and smart living. Finally, the insertion of tourism into the emergent paradigm of circular economy.*

Research limits. *Although the completeness in the collection of experiences in a so vast and dynamic field is a utopia, it is honest to recognize that the speed of technological evolution prevents to present a set of initiatives fully updated, together with their outputs.*

Practical implications. *The design of tourism destinations should not be based on harnessing the ICTs proliferation only, but, more importantly, on the need for balancing all the beneficiaries -from internal publics (residents, local people) and external ones (visitors in one single word, both excursionists and tourists)- through the paradigm of "smartness", that, in the search for a more sustainable tourism industry, guides people's living conditions.*

Originality of the study. *The study promotes to moving forward in this area through a cross-fertilization between theory and practice, with the outline of a number of recommendations together with some suggestions for further research in a still under explored field of study.*

Key words: *smart destinations; tourism management; sustainability; good practices*

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1. Introduction

2017 was designated by the United Nations (UN) the "International Year of Sustainable Tourism for Development", in the context of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs). This has represented an opportunity for aligning all the stakeholders of the tourism industry (particularly public administrations, private business and knowledge agents, including researchers in universities) in a joint effort aiming to progress further in the creation of more sustainable tourism companies and destinations. As a result, the World Tourism Organization (UNWTO), the United Nations specialized agency for Tourism, has been mandated to promote tourism's role in the following five areas: inclusive and sustainable economic growth; social inclusiveness, employment and poverty reduction; resource efficiency, environmental protection and climate change; cultural values, diversity and heritage; mutual understanding, peace and security. Thus, this paper can be inserted within this framework and the strong need of moving forward in this direction. As a proof of this need, Romao and Neuts (2017) have recently found that in those European regions where tourism assumes wider socio-economic relevance, the contribution to the achievement of the UN's "Millennium Goals", established for the period 2000-2015, has been relatively poor. Clearly, the challenge is to improve this performance with regard to the SDGs in the new 2030 Agenda.

It is unquestionable today that competitiveness is more and more supported on the ability of companies and destinations to differentiate themselves based on the treatment of data flows from a variety of sources (social networks, platforms, mobile telecommunications, etc.) that, once properly integrated, lead to the generation and transfer of knowledge and the creation of new opportunities (Baggio and Cooper, 2010). In short, the success, when managing any organization, depends more and more on the use of the information generated in it and in its environment. Accordingly, even the UN, within the above-mentioned framework of its 2030 Agenda, already declared in 2015 the increasing relevance of data revolution for sustainable development.

Looking for the achievement of higher levels of sustainability, the "smart city" approach has received, at urban scale, considerable attention in the last few years (Buhalis and Amaranggana, 2014, 2015), being applied in the tourism sector under the term "smart destination" (Yoo and Gretzel, 2016; Dos Santos Júnior, *et al.*, 2017). In fact, Smart Tourism Destinations (STDs) have become a prime factor in the construction of smart cities. Nevertheless, the concept of "smartness" has also emerged in the literature connected to regions and their smart specialization (Romao and Neuts, 2017).

In tourism, its foundation lies in the potential of the advances of information and communication technologies (ICTs) to generate innovative solutions able to address an issue of such great impact as sustainability. As stated synthetically by Gretzel *et al.*, (2015a, 175), this is "a strategic tool for tourism development". As noted, the term development is often "associated with economic return and impacts can be both positive and negative" (Mota *et al.*, 2018, 103). In the current technological age, "data and analytics can reveal finer levels of distinctions, and one of the most powerful uses is micro-segmenting a population based on the characteristics of individuals. Using the resulting insights to personalize products and services on a wide scale is changing the fundamentals of competition in many sectors, including travel and leisure" (McKinsey Global Institute, 2016, 9).

In general, smartness (or intelligence) represents the ability for a better understanding and solving problems (such as those related to sustainability) using knowledge, that is, based on data and information (Vargas-Sánchez, 2018). Also refers to make something reducing costs, time and the external (social and environmental) impact and to the improving efficiency (Caputo *et al*, 2017). In this effort, recent developments, driven by ICTs, in the capacity of integrating and treating huge volumes of structured and unstructured data (Big Data, Open Data) have been extremely useful.

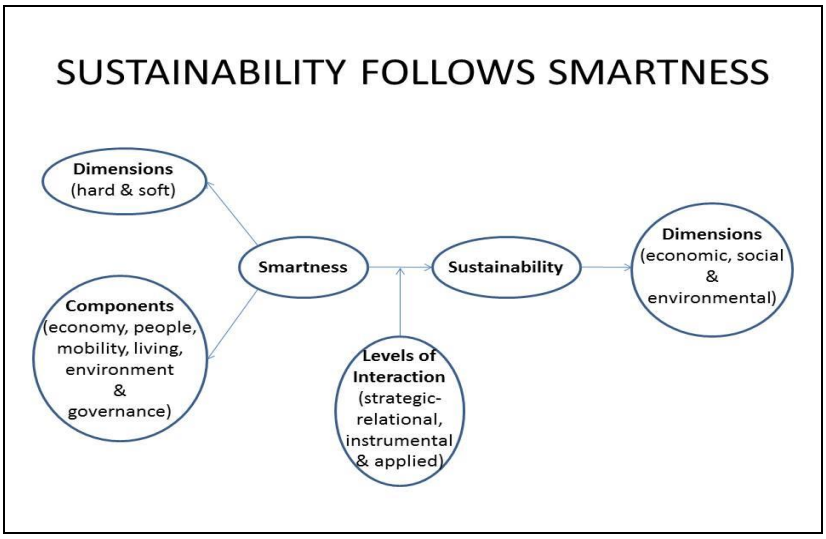
According to Dos Santos Júnior *et al.* (2017), from the point of view of competitiveness, it is vital that sustainable tourism destinations define and implement smart strategies. Therefore, in this paper, the smart approach is presented as a useful path to move forward in the direction of

achieving a more sustainable tourism industry, in the same manner that Postma *et al.* (2017, 20) recognize that, for certain type of organizations, "sustainability can be achieved through efficiency, intelligence and dedication". Therefore, smart tourism and sustainability have been matched in this study, with the aims to present:

- A review of the literature in the intersection of smart tourism and sustainability, trying to unravel the link between both concepts;
- A collection of experiences focused on the various components of smartness, implemented with satisfactory results and aligned to the management of sustainability issues in its three dimensions (economic, social and environmental); they could be presented as benchmarks for checking possible gaps between theory and practice;
- A contribution to moving forward in this area through a cross-fertilization between theory and practice, with the outline of a number of recommendations together with some suggestions for further research in a still under explored field of study.

Figure 1 tries to make clear the basic architecture of the relationship between smart tourism and sustainability, which is developed in this paper and, consequently, as a means to understand better its structure, in its theoretical features and with regard to the experiences selected.

Fig. 1: Architecture of the research



Source: own elaboration

Consistently, the layout of this paper includes three more sections: literature review, experiences, and conclusions, in addition to its methodological background, which is described next.

2. Methodology

To achieve the research objectives, this paper was mainly guided by a qualitative analysis focused on peer-review scientific articles and case studies/experiences (Patton, 2015), which were derived from databases and web analysis. Specifically, two phases were contemplated, as follows.

Firstly, a search was performed in recognized scientific repositories: ISI Web of Science and Scopus, complemented with Google Scholar. The data extraction took place at the intersection of "smart tourism" and "sustainability" in the topic field, which considers the title, keywords and abstract in the abovementioned databases (Barki *et al.*, 1993). The obtained documents were filtered in order to eliminate repeated ones. Then, the abstracts of the articles were analyzed for verifying their relevance with the objectives of this research. When necessary, the main body of the articles

was read to assess whether they dealt with the interplay between smart tourism and sustainability fields.

Secondly, for the identification of experiences and the collection of information in the intersection of both concepts (smart and sustainability), three complementary sources were used: a) desk research based on our own knowledge and additional search using the available online resources (Google and Google Scholar); b) the program of the 1st UNWTO World Conference on Smart Destinations, hosted in the Spanish city of Murcia in February 2017, as long as enough information is accessible about the experiences connected with tourism sustainability presented in that conference; and c) an experts consultation via TRINET (Tourism Research Information Network, http://www.tim.hawaii.edu/trinet), the largest international tourism research and education community, and other groups of tourism academics and professionals in social networks (Facebook and LinkedIn). This collection took place over a four weeks' period in March 2017.

Google was used to query the documents presented on the first three pages. The corresponding search results were utilized to identify further sources. The collection of documents contemplated reports, academic case studies, online articles and smart city project descriptions.

3. Literature Review

This section has been organized in four sections, consistently with the aims of this paper. These subsections cover, respectively, the conceptualization of the two main topics tackled in this work: smart tourism and sustainability; the third subsection is devoted to the literature in the intersection between both and the final one to unravel how smartness influences sustainability.

3.1 Smart Tourism

Like smart cities (Giffinger *et al.*, 2007), smart destinations are waking up increasing interest, becoming one of the hottest topics today (Yoo and Gretzel, 2016). Although started in the professional side of the industry, the academic community is also taking its role of working on the provision of a theoretical base much beyond specific solutions provided by tech companies and consultancies. That interest coincides with a context of structural change in the tourism industry (impact of ICTs, new patterns of demand behavior, emergence of new business models, greater environmental sensitivity, etc.) which requires new management approaches guided to ensure environmental quality and sustainability, among other objectives quoted by Ivars Baidal *et al.*, (2016).

It is evident that the current context of change requests to rethink the traditional formulas of tourism management and to evolve towards new organizational frameworks and more innovative strategies (Buhalis and Amaranggana, 2014). The smart destinations approach can help to encourage this process. However, the evolution towards smart destinations entails an obvious organizational complexity and an investment of economic, technical and human resources proportional to the scope of the project. In this regard, the key lies not in a smart destination as an ideal state, probably unattainable, but, rather, according to the concept of learning organizations (Cooper and Sheldon, 2010; Schianetz *et al.*, 2007), in the generation of destinations that adapt to change and continuously learn to improve their sustainability and competitiveness.

Based on Vargas-Sánchez (2018), a tourism destination is a complex business ecosystem, which has to be managed, nowadays, under the paradigm of smartness favored by tech developments, with the aims to promote its sustainability and people's quality of live. More specifically, the foundation of that new paradigm is in the potential of the advances of ICTs to address issues of great impact such sustainability, universal accessibility, innovation and governance, with solutions based on these technologies. Nevertheless, as concluded by Boes *et al.*, (2016), the hard component of smartness, based on ICT infrastructure, has to be complemented with soft elements such as creativity, social and human capital, and leadership, which are fundamental to

give meaning to the hard smartness. Therefore, "destination managers have to integrate the entire range of smartness components and ensure interoperability and interconnectivity of both soft and hard smartness" (Boes *et al.*, 2016, 120). This implies that the only integration of technology within a tourism destination is not enough for becoming a smart one.

This ecosystemic approach has been also used by Polese *et al.* (2018), who propose a model, called "Smart Service Ecosystem", suitable for hypercompetitive and experience-based sectors, such as tourism. This model is oriented to manage and optimize value co-creation and sustainability in the long run, fostering a transition from innovation to social innovation.

In the specific field of STDs, a literature review can be found in Vargas-Sánchez (2016), who, in addition, suggests the following definition of this concept, still emergent and with a fragmented profile: "A STD is one that, from a shared vision by the actors involved in it, is based on an extensive use of cutting edge technologies in order to create an advanced digital space ... able to improve the whole management of the destination and, therefore, its differentiation and competitiveness. A STD is built on the values of innovation and sustainability, working to improve the tourist's experience and enhance the quality of life of local communities" (189-190). Thus, the benefits are not only directed to tourists, but also to residents in host communities, where tourists can be considered as temporary residents. Originally, the concept of smart city is focused on its residents and their quality of life, whilst in its application to tourism the enhancement of tourist/visitor experience is pursued as well and in a balanced way, making both compatible.

The data-driven logic for managing a destination is emphasizes by Gretzel *et al.*, (2015b, 181), who defines "smart tourism" as a "tourism supported by integrated efforts at a destination to collect and aggregate/harness data derived from physical infrastructure, social connections, government/organizational sources and human bodies/minds in combination with the use of advanced technologies to transform that data into on-site experiences and business value-propositions with a clear focus on efficiency, sustainability and experience enrichment". From their side, Buhalis and Amaranggana (2013) underline that bringing smartness into tourism destinations implies the capacity to interconnect all stakeholders through advanced technological platforms. This could allow the instant exchange of data related to tourism initiatives/activities by providing multiple touch points that could be accessed through a large variety of end-user devices. In this way, these devices could support the creation and the facilitation of real-time tourism experiences and, consequently, improve the effectiveness of tourism resources management throughout the destination (Buhalis and Amaranggana, 2013).

As an example, Spain has been the pioneer country leading a process of standardization in this field. As a result, the first official norm on STDs was published in 2016, later updated in 2018: the UNE 178501 on the requirements of a management system for Smart Tourist Destinations, which follows ISO structure directives. Another norm was also launched in 2018 (UNE 178502) on indicators and tools for STDs.

3.2 Sustainability

Although the relationship between tourism and sustainability has always been present (Torres-Delgado and López Palomeque, 2014), it is not until the 80s that the consequences of this relationship began to be explicitly analysed by using rigorous ways in order to observe the impact of this interplay (Buckley, 2012). In this respect, in the tourism industry a certain lack of experience is found in the management of sustainability constituents, associated with the incapacity to assume an integrated vision of one's own business (Hobson and Essex, 2001).

As stated by Epuran *et al.*, (2015), the consequence of the principles and provisions of the two key documents linked to Sustainable Development (Rio Declaration and Agenda 21, dated in 1992) was that national economies (i.e., the developed ones), international organizations (i.e., United Nations and the Organization for Economic Cooperation and Development) and companies, non-profit organizations, governments and civil society have become increasingly anxious in order to integrate sustainability dimensions in their activities. As a result, for example, already in the same

year the "International Hotels Environment Initiative" was launched, in an attempt of promoting environmental and social responsibility in the industry. The last global initiative, already mentioned in the introductory section, has been taken by the UN, designating 2017 as the "International Year of Sustainable Tourism for Development".

The sustainable peculiarity of tourism contemplates different aspects: the responsible use of natural resources, including the environmental impact of activities (i.e., waste generation, pressure on water, land and biodiversity, etc.), the use of clean energy resources, heritage protection, safeguard of natural and cultural integrity of destinations, quality of jobs, positive effects on local economy and, more recently, the integration of the principles of the circular economy paradigm. These principles have been observed in tourism strategies and policies defined and implemented at national and regional level, even if they have not materialized adequately in concrete actions and interventions.

Currently, most tourist establishments focus on economic issues, but with interest on social and environmental matters (Buckley, 2012). Although many tourist units only selectively implement sustainable development practices, especially those that could give an advantage in terms of profitability or image (Lane, 2009; Sheldon and Park, 2011), it is fair to recognize that sustainability in tourism, as in other sectors, is very difficult to achieve (Casagrande and Rinaldi, 2002). According to the vision projected in the "White Paper of Business Sustainability" (2014), drafted under the auspices of the World Economic Forum, it is admitted that businessmen/investors, in general, begin to accept that "financial success and firm survival are dependent on their contribution to the development of a clean environment and to the human rights of societies where they operate" (http://www3.weforum.org/docs/GAC/2014/WEF_GAC_HumanRights_BusinessSustainability_WhitePaper_20 14.pdf).

3.3 Intersection between Smartness and Sustainability

Sustainability is, clearly, one of the core values or principles to be injected into the work of any destination and its actors, both public and private ones. Thus, in an endless search and learning for its improvement, the smart paradigm paves the way towards a more sustainable destination in all its dimensions. Following Pawlikowska-Piechotka *et al.* (2016), sustainable tourism and smart destination together lead to the protection of environmental resources and the safeguard of local values and traditions.

As a matter of fact, the literature shows that sustainability has economic, social and environmental dimensions; just as a token, in 2005 the World Tourism Organization proposed the "three pillars" to delineate sustainable tourism: "sustainability principles refer to the environmental, economic and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability". In addition, it has to be noted that tourism development can only be sustainable if it has been strategically planned to reach objectives with concrete effects over the long term in those three pillars: present needs have to be satisfied without jeopardizing future generations' needs.

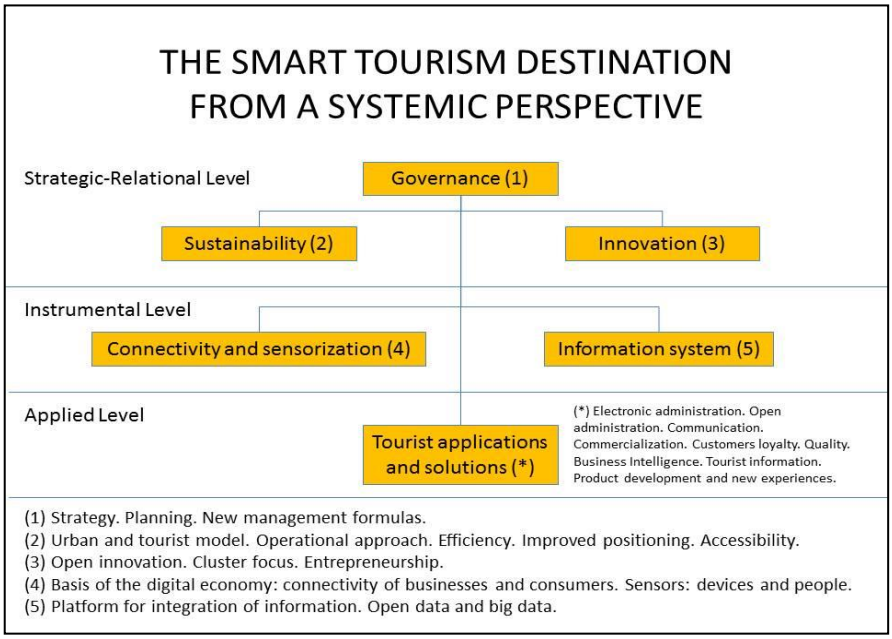
As a recent landmark, the conclusions of the 1st UNWTO World Conference on Smart Destinations (February 2017) have considered smart destinations as key drivers to sustainable development, specifically in terms of measurement and evidence-based decision making, prioritization and anticipation towards the future.

According to Ivars-Baidal *et al.* (2016), the STD approach requires a global project that incorporates strategic vision, technological adaptation, sustainability and innovation, essential aspects of the so-called "new tourist economy". In this line, a theoretical model of a STD is proposed by these authors, which pivots on five interrelated areas (governance, sustainability, connectivity and sensorisation, information system and innovation), from whose integration a differentiated tourism management approach arises.

Graphically, figure 2 synthesizes the system of a STD, by integrating the described areas. The system is composed of three interrelated levels, in which the technology, as a metafactor, is present

(Chourabi *et al.*, 2012), with a variable character but with the involvement of public and private agents, as an essential element in all areas. The first encompasses the governance, sustainability and innovation of the destination, so that it has a strategic and relational character; at this level the transformation of the destination is led and made possible through the collaboration of all the actors. The second level is instrumental and includes the areas of connectivity and sensing together with the information system. Finally, the third level includes the concrete application of smart solutions that benefit the tourist activity. It is clear, therefore, that a STD is not a purely technological project and that it has to serve as a catalyst for a greater participation and involvement of local society in the process of tourism development, as well as for the promotion of collaborative processes that will be facilitated by the application of ICTs.

Fig. 2: STD from a systemic perspective



Source: own elaboration based on Ivars-Baidal *et al.*, 2016.

With regard to destination sustainability -linked to the model of urban and tourism development, which also includes accessibility for people with disabilities-, this goal cannot be waived for any tourist space. Smart destinations favor the application of sustainability principles and, therefore, contribute to their image and positioning, as well as to the promotion of a more rational and efficient management of natural resources. In addition, it is opportune underline that tourism sustainability cannot be observed as a matter of rules or solutions applicable in any circumstance. According to Astiaso *et al.* (2012), the challenge is to identify the appropriate solution for each particular type of context in which an action is required.

It is important to make clear that becoming a STD is not an end in itself, but rather a framework for adapting tourism management to the current demands, such as the requirement of sustainability. However, this approach raises implementation issues. Not all destinations have sufficient resources to tackle a comprehensive project that integrates the five aforementioned areas. For this reason, there is a risk that this approach will cover specific projects with a lack of the global perspective that it is supposed should have. In fact, the current phase of promotion of initiatives self-designated as smart (mobile applications, very apparent sensor systems but with limited impact, web pages of, supposedly, the latest generation, etc.) should be overcame to open a stage of project development with a real impact on competitiveness and sustainability of destinations.

As stated by Pawlikowska-Piechotka *et al.* (2016), in the tourism context sustainability implies the necessity to balance limits and usage of resources (natural and cultural), as well as to consider interests of all stakeholders (local communities and visitors) in the sustainable development paths.

Besides, they add that "sustainability in tourism means also limits of visitors in the host areas" (Pawlikowska-Piechotka *et al.*, 2016, 319), which leads to the controversial issue of the carrying capacity and its determination.

Overtourism is a problem that very popular destinations, attractions and events are struggling to deal with, so that the data-driven logic supported by the smart approach, facilitated by tech developments, can be extremely useful to manage it, for instance making decisions in the line of diversifying tourism flows, as an enhancer of sustainability. In this sense, Epuran *et al.*, (2015) propose the concept of "smart growth", which means the creation of value for customers, high productivity levels and adequate management of risks determined by growth. Consequently, the idea of "smart growth" (Hess, 2010) substitutes the phrase "grow or disappear" with the expression "improve in order to stay competitive"; this strategic framework leads to the acceptance that a healthy growth and a sound development for firms and also destinations cannot be obtained by omitting their externalities on the environment and the society or the effectiveness of their activities.

If this is a problem caused by success, and success has been, in many occasions in history, the beginning of failure, in order to maintain the economic, environmental and social benefits of tourism development, while reducing or mitigating undesirable impacts of any type, then, success should be measured differently than a steady growth in the number of visitors and overnights, going much beyond this mere quantitative view. For instance, in Europe some cities are seeking a solution in which tourism can provide a net benefit to locals and visitors alike. Emblematic in this direction is the case of Copenhagen that has declared "The End of Tourism as We Know It" in its 4-year destination strategy. Specifically, in this strategy, it is stated that "we will not measure or be measured solely in terms of bed-nights or business attracted. We need more effective, insightful and relevant measures of success and value creation to reflect the contribution of our industry to society at large" (p.15 in http://localhood.wonderfulcopenhagen. dk/).

More in detail, Garau (2015) proposes the following evaluation criteria for sustainable tourism development:

- Local economic development: fostering the development of local companies; stimulating the creation of professional profiles, and jobs, intended to strengthen the sustainability of the tourism sector; promoting public and private alliances; spurring the long-term sustainable construction and renovation of buildings.
- Environmental development: giving support to activities aimed to tourism diversification and with a potential to divert tourist flows and mitigate congestions; safeguarding and enhancing local heritage of any kind; stimulating the demand for the attainment of environmental certifications. Nevertheless, the environmental certification landscape -with a large number of standards offered- reduces clarity, in the sense that they become less recognizable and less trusted by travelers, especially since each geographical region has its own certification scheme.
- Social development: encouraging the effective integration of the variety of policies that affect the tourism sector; definition of participatory practices oriented at promoting the latest ICT tools for tourism applications; moving towards a place-based approach in which residents are effectively integrated with tourists; facilitating opportunities that encourage the local community to discover unique regional peculiarities.

3.4. The link between Smartness and Sustainability

Two streams co-exist in the literature. Although sustainability can be considered an attribute of smart destinations, in our view the conceptualization of smartness as a driver of sustainability is more revealing, as display a relationship in which smartness is the cause and sustainability is the effect.

Certainly, it is hard to label a tourism destination as smart without a good record on sustainability issues based on specific plans, with their corresponding indicators, targets, actions, etc.; in other words, without a decisive bet for sustainability, being neglected to a certain extent.

Nevertheless, the use of digital advanced technologies and a tourism governance mode based on a data-driven logic and innovation capabilities are, when jointly implemented, essential inductors of higher levels of economic, environmental and social sustainability. Table 1 eases the visualization of this relationship.

Tab. 1: Smartness as a Driver of Sustainability in Tourism Destinations

SMARTNESS		SUSTAINABILITY
Dimensions	Levels of interaction	Dimensions
***Hard**: Use of digital advanced technologies (such as Big Data or Internet of Things). ***Soft**: Governance based on a data-driven logic and innovation capabilities.	***Strategic-Relational**: strategy, planning, innovation management … ***Instrumental**: connectivity of tourist agents and visitors, sensors, information system … ***Applied**: applications and solutions. (Figure 2)	***Economic**: cost savings, reputation, effects on local economy, quality of jobs, etc. ***Social**: preservation of local heritage, way of living and culture in general; mitigating inconvenient caused by overtourism, etc. ***Environmental**: efficiency in water/energy consumption, reduction of greenhouse gases emissions, minimizing congestion problems (growth), etc.

Source: own elaboration

Table 1 shows the various levels to which that interaction can be established, following Ivars-Baidal *et al.*, (2016). Under a short-term perspective, some sustainability issues could be improved through the implementation of particular applications and solutions, but without a global view and an integrative effort (lower level). Nevertheless, a long-term sustainability strategy and planning is advisable, placing the focus on the strategic-relational level (upper level). The intermediate one is instrumental: connectivity and sensorization mechanisms, together with an effective information system, will facilitate the application of concrete actions, but in an articulated and consistent manner inspired by a systemic (not partial) perspective of sustainability in the destination under scrutiny.

As the strategic management literature has shown extensively, a sustainable competitive advantage is the result of a balanced combination of technological and non-technological resources (human and managerial). Within the smart paradigm, technology is a necessary condition, but not sufficient. Taking this point, the governance of destinations rises as a key factor for success in an industry that, being dramatically reshaped by ICTs advances, needs new forms of governance that, built on knowledge sharing and innovation capabilities, are able to deal with the challenges of today, including those related to higher and higher sustainability requirements, making the right decisions under the basis of the data provided by those technologies. This corresponds to the soft dimension of smartness mentioned in the literature, complementary to the hard dimension represented by the simple use of ICTs (Boes *et al.*, 2016).

To this respect of governance revisitation, the Spanish Norm UNE 178501:2016 on Management System of Smart Destinations (MSSTD) is a pioneer standard built on four pillars: innovation, technology, universal accessibility and sustainability (governance was added in its 2018 update). With regard to the later, the MSSTD must acquire (to be awarded with this certification) a documented commitment to improving the sustainability of the destination and integrate that commitment into its strategy in a transversal manner, from several perspectives:

1. Protection of economic activity. It must:
   - promote decent and innovative work opportunities, as well as training for local employment and digital skills;
   - ensure safety (physical safety of buildings, facilities and transport, including emergency procedures, food safety and health response);
   - develop resilience (adaptability of tourist services to the needs and requirements of tourists).
2. Environmental protection. It must be responsible for the measurement of environmental parameters; the control and follow-up of the public transport system and pedestrian mobility.
3. Quality of life. It must consider ethnic and social integration; gender equality; health (both public and private health services for tourists).

4. Socio-cultural impact of tourist activities. It must take into account aspects such as: the interaction between citizens and tourists; the sports, recreational, leisure offers; the preservation of the natural and cultural heritage.
5. Territorial cohesion. It must favor the culture of social responsibility and the involvement of stakeholders.

It is worth to note that number 1 corresponds to economic sustainability, number 2 to environmental sustainability, and numbers 3, 4 and 5 to social sustainability.

Consequently, a Smart Sustainability Initiative should project a long-term vision of the corresponding destination and, accordingly, plan all the necessary technological and non-technological resources to achieve measurable goals, with specific actions, in the five following domains: protection of economic activity, environmental protection, quality of life, socio-cultural impact of tourist activities and territorial cohesion. For making theory actionable in practice, valid and reliable measurements in those domains are required, which can represent an extra challenge.

4. Experiences

As a gap between the academic approach to a particular topic and its development in the real world usually exists, a collection of smart experiences in its intersection with sustainability issues in tourism follows. In the concluding section, the above-mentioned gap will be discussed, together with some recommendations to bridge it.

The set of experiences, which will be summarized below, has been identified using the methodology described in the corresponding section. We acknowledge that this list is not, by far, exhaustive; for sure some other valuable experiences exist, even without the novel label of smart, but in our understanding the selected bunch can provide a good enough view to fulfil the practical aim of this paper. Very likely, others not mentioned in the following subsections can also fit within the "mould" described here.

The next step was drawing that "mould", that is, how to present these experiences, not as a mere list but under some consistent criteria. Among others, the work of Alami and Aria (2016) provides a reasonable framework to deal with this concern. Bearing in mind that a tourist can be considered a temporary resident, and that, as already referred, the concept of Smart Destination has its antecedent in the concept of Smart City, where smartness has been incorporated into six components (Alami and Aria, 2016; Gajdosík, 2017; Sajid Khan *et al.*, 2017), the same ones can be also transferred to a STD: smart economy (competitiveness), smart people (social and human capital), smart governance (participation), smart mobility (transport and ICTs), smart environment (natural resources) and smart living (quality of life). This is the model follows, for example, by the Smart Dubai Initiative.

These components have evident implications on the economic, social and environmental dimensions of sustainability, as suggested in the next table (2). In this way, we interconnect the dimensions of sustainability, already inserted in table 1, with the above-mentioned components of smartness, building another bridge between both concepts and reinforcing the perspective on how smartness influences sustainability.

Tab. 2: Correspondence between components of Smartness and dimensions of Sustainability

Smartness: Components			**Sustainability: Dimensions**
Smart Governance	Smart Economy	→	Economic
	Smart People + Smart Mobility + Smart Living	→	Social
	Smart Environment	→	Environmental

Source: own elaboration

Consistently, the selected experiences, in their application to tourism, are presented following this scheme.

4.1 Economic Sustainability: Smart Economy

Since a smart economy, founded on digital advanced technologies, suggests a smart tourism, it is argued that a decisive step forward has been the bond created between tourism and smartphone apps (Ebi, 2014), exploiting the use of ICT as a tool to define an efficacious way of providing services and managing tourism destinations (Achaerandio *et al.*, 2011).

For instance, in the Philippines, Cebu city has developed a specific smartphone app in order to promote local events and initiatives, especially its annual Sinulog Festival; in this respect, the guide considers concretely the story of the festival - a religious and cultural event that includes a grand parade and street dancing- as well as listings of different places to stay and attractions, including heritage tours and local cuisine. Similarly, the bilingual app of Quebec is focused on the promotion of tourism in the Quebec region of Canada: it presents accommodations, restaurants, shopping places and local events, but also offers tourist information (i.e., how to get there, directions, tourist information centres and public restrooms, descriptions of regional resources and pictures). The two above-mentioned apps are among many others featured in the Smart Cities Apps Gallery (Enbysk, 2014).

In the same way, Dubai has operated to develop a consistent number of mobile applications, synthesized by Sajid Khan *et al.* (2017, 15). In addition, "tourists in Dubai can explore key solutions including where to go and what to do using NFC (Near Field Communication) tags that are integrated with their individual devices. Cloud computing has contributed largely to the efficient use of information and its sharing. Tourists can connect with systems seamlessly without having to download the application" (Sajid Khan *et al.*, 2017, 16).

Beyond the use of apps for travellers, London has developed an innovation hub to address pressures on resources whilst creating new economic and research opportunities through a network of private and public organizations devoted to develop the city in areas such as extensive Wi-Fi infrastructure in parks, smarter crowd management, environmental sensing, etc. In this way, social and environmental sustainability of the destination is also favoured.

4.2 Social Sustainability: Smart People

The interconnectivity of a wider and wider range of actors can be observed as a relevant feature of the smartness concept (Gretzel *et al.*, 2015a; Boes *et al.*, 2016). In fact, cutting-edge technologies and human actors "form a socio-technical synergy aiming towards co-creating value" (Boes *et al.*, 2016, 109; Meijer and Bolivar, 2016). In this line, Singapore established a social media platform called 'blockpooling' that strengthens local communities and fosters a more efficient use of resources. For example, the platform utilizes postcodes to help people find others in their neighbourhood who have items they are willing to share or borrow. People can also connect with others in their block for seeking advice, to host events for neighbours or inform them about activities, such as building works that might inconvenience them (Alami and Aria, 2016). Tourists, as temporary residents, can be also users and beneficiaries of this online platform (Buhalis and Amaranggana, 2014).

Within the program "eCulture Agenda 2020", Hamburg has included the creation of digital access to cultural goods, clearly tourism products of increasing importance. The aim is to stimulate people to participate in the cultural programmes of the city through digital offers. The principal cultural organizations have started the process of digitizing their collections and the Cultural Department of Hamburg has developed the App "Kulturpunkte" for mobile devices by offering the possibilities to experience artworks, monuments, photos and to exchange their opinions/suggestions with other people.

Finally, the "Smart Airport Experience" in London City Airport well worth a mention. This is an initiative aimed to use the new technologies to improve the customer experience in the airport. For instance, the passengers can easily use the pre-order retail, food and beverage services prior to arrival at the airport (http://www.airport-business.com/2015/06/london-city-investing-smart-airport-experience-expedite-passenger-journey/).

These initiatives underline that tourism managers have the possibility to develop innovative solutions within the boundaries of the smart approach, in a way that is able to generate value for all stakeholders in the destination and, in general, for the society (Boes *et al.*, 2016; Buhalis, 2015).

4.3 Social Sustainability: Smart Mobility

Public and private actors in different cities and destinations have started to use digital platforms and integrated technological tools for enhancing interconnectivity and interoperability, promoting also sustainable urban mobility and competitiveness (Del Chiappa and Baggio, 2015). The main objective here is to enhance mobility while at the same time reducing congestion, accidents and pollution. It easily means to develop "a new understanding of urban problems, effective and feasible ways to coordinate urban technologies" (Del Chiappa and Baggio, 2015, 146).

Thus, in Rio de Janeiro various technology tools (sensors, satellites, cameras, GPS systems) are set up to collect real-time information on traffic, weather, lighting, electricity use and parameters to manage transport flows, reorient cars around accidents, congested areas and contribute to emergency services (Alami and Aria, 2016) with evident effects on tourism.

Miami replaced its 25-year-old fare collection system, i.e. Miami-Dade Transit (MDT), with a smart card-based system - called EASY Card -; it was so successful that two more agencies in the region joined, including Hialeah Transit (buses) and South Florida Regional Transportation Authority (commuter rail), which added even more convenience through the "one card fits all" interoperability offered by Council Lead Partner Cubic Transportation Systems (Council Lead Partner Cubic Transportation Systems, 2013).

In New York, talk to a street light and there's a chance it will talk back (Ebi, 2015a). An energy start-up generated by Council Lead Partner GE has set up the world's most helpful street lamp in a New York intersection. It operates as a digital assistant in the current generation of smartphones, but the effective power derives from its capacity to obtain information from city sensors and services and provide information in a way that helps people. People may line up to discuss to New York's personable lamppost, but the platform is able to answer the same type of questions and render information through other intelligent street lights that people would interact with through a smartphone app. While only one lamppost may be capable to discuss with people, through a cohesive platform all streetlights could have a lot to say.

Making cities more walkable is a focus throughout the world. "Walkability City" tool is defined as a new urban dimension, a new layer constructed through observation of pedestrians and their environment (SUMA, 2017). Walkable City is aimed to make more space available for pedestrian to walk (Walking 2.0 and Future Mobility, 2014) and already exists in America and Hong Kong (Brownlee, 2016).

Finally, a mention to Seattle, where a smarter use of technological tools is helping to move people through the city's downtown core and, among other advantages, to more effectively deal with storm water (SCC Staff, 2016).

4.4 Social Sustainability: Smart Living

Places that are smart about tourism also tend to be places that have fully embraced the concept of what it means to be a smart city. In addition, this movement indicates smart city improvements for residents and travellers alike, which is in line with the systemic perspective that is required for a balanced development of this paradigm.

In Europe, Barcelona and Amsterdam are prime examples of the application of innovation for tourism development by harnessing big data, open data, small data, and sensor technology for mobile phones, which would not improve inhabitants' life only, but also enhance visitors' experiences; e.g. free Wi-Fi, free charging mobile battery station, parking application, biking application (Midgley, 2009).

The Anacostia Waterfront Initiative (AWI), a District of Columbia (US), is conducting communities and residents to new businesses. AWI is a trailblazing endeavour that is directed to remove physical barriers and to open a gateway to the future by transforming a once disconnected and deficient urban environment. Council Associate Partner CH2M is working on this visionary urban revitalization, by helping to transform neighbourhoods in the nation's capital and create lasting legacies by extending their unique strengths (Council Associate Partner CH2M, 2013), which will contribute to attract tourists as well.

The focus on social issues fosters a set of heterogeneous initiatives in different sectors, such as education, well-being, health and safety (Ahvenniemi *et al.*, 2017). In this respect, a relevant experience is that of Charleston city, in South Carolina, as an important hub of industry, shipping and tourism that receives more than four million tourists every year, oriented to experience its fine cuisine, historic architecture, festivals and arts. However, this is a main challenge for Charleston Police Department, because it is more committed to guarantee public safety and to protect local community and visitors. To solve this issue, Charleston city has adopted innovative systems that allow to connect and to improve interagency communications among different jurisdictions, supervisors and officers by creating a useful platform to monitor and exchange information and to collaborate for solving security problems (Verizon, 2015).

4.5 Environmental Sustainability: Smart Environment

Smart environment is developed based on ecological infrastructures which is beneficial not for tourists only but for residents as well. For instance, a wetland park located in Zhangzhou city, Fujian (China), develops an application of smart technologies for the ecosystem service function and value, turning this site into a place for leisure and entertainment (Zhao and Wang, 2015).

Another example of smart heritage protection and management is the city of Sassi di Matera - declared a World Heritage Site- that is expected be the first geology-focused Italian smart city. It has been in an experimental phase until now, and its urban model will contemplate sustainable protection measures for environment and economic sectors such as tourism, including energy efficiency to tackle traumatic events and changes. Its smart heritage protection and management is nurtured by technologies such as iBeacons, which provides opportunities linked to a custom-made museum visits, collaborative platforms, end user devices, etc.

According to the necessity to achieve the energy efficiency in terms of energy systems and source energy (Ahvenniemi *et al.*, 2017), London's tube trains recycle waste energy into electric power. The city has installed inverter systems at its underground stations, which reclaim energy that would generally be lost when the subway is breaking. The first week trial showed that the breaking energy reclaimed at one station was enough to power that entire station for two days (Smart Cities Council, 2015). This is in line with the highlights issued by the Energy Research Alliance (EERA), which suggests that cities have to move their energy systems towards more sustainable ways. Specifically, it considers necessary to develop integrated systems as well as innovative, intelligent approaches to the design of energy systems (EERA Joint Programme on Smart Cities, 2013).

Likewise, Seoul's city government choice was Clean Cubes from Council Associate Partner Ecube Labs, a solution that showed notable improvement in public sanitation in three months. This solution, including real-time monitoring, cut waste collection costs by 83% and increased the recycling diversion rate to 46% (Seoul Metropolitan Government, 2015).

Calgary, a city in the Canadian province of Alberta, turned into a data-driven system to predict and manage flooding. Spring rains and snow melt pour into the rivers and reservoirs that feed the Calgary's water supply. Consequently, downtown businesses and residents are faced with

unpredictable floods that could do relevant damage in economic terms (City of Calgary, 2015).

For preservation and conservation purposes, a smart application has been developed in Canada, which intends to underline the importance of municipalities to the fight against the emerald ash from borers. Besides, the city of Saint-Constant, in Quebec, is adopting the JMap Mobile application to do a geo-located inventory of all the trees infected within its territory as well as to quickly create, modify, plan and update the inventory of trees infected. JMap Mobile is the reference real-time tool directed to locate, treat and monitor the real condition of trees infected by this scourge (Council Associate Partner K2 Geospatial, 2014).

4.6 Smart Governance: a synthesis

The progress towards a more sustainable tourism industry through the implementation of smart initiatives related to the economy, people, mobility, living and environment of destinations would not be possible without a new lens to tourism governance based on the concept of a smart tourism business ecosystem (Vargas-Sánchez, 2018). Definitively, tourism governance has to be revisited under the new horizons and challenges open by the smart paradigm, which puts in check the traditional forms of governance.

To move in this direction, within a context of lack of predictability and controllability of the more and more complex tourism mosaic, the reinforcement and continuous update of the technological base is essential to reinforce the capabilities of destinations' managing bodies, although it is not the only factor to consider to succeed.

In this line, as mentioned by Buhalis and Amaranggana (2013, 558), "Stockholm collects real-time information from scattered sensors in the city and processes them in order to provide accurate city information through end-user devices; which reflect the use of ICT as a predictive tool to implement a smarter way of managing Tourism Destinations".

In Paris, its government has explored how to stimulate citizen participation in the decision related to how the city spends its money. Citizens (and tourists can be considered temporary residents) propose projects via an app and the most voted ones are realized, such as the creation of vertical gardens along buildings, the set-up of recycling stations, gardens in schools and co-working spaces for students and entrepreneurs (Blanc, 2015).

With cloud-based productivity tools, the Danish city of Odense has gained efficiency, fostering collaboration: its municipality employees have the possibility to work more easily and efficiently while complying with government security standards (Microsoft, 2015). Also in Denmark, the experience of Smart Aarhus initiative outstands: technical and social problems that the city of Aarhus had to deal with were addressed by "integrating and synchronizing its systems for water, transportation, energy, healthcare, waste removal/recycling, and so on" (Sajid Khan *et al.*, 2017, 3). All these improvements in public services favor their users, and tourists can be their beneficiaries.

5. Conclusions

As stated by Sajid Khan *et al.*, (2017), "sustainability is at the crux of the growth of smart tourism and more destinations are now prioritizing it as a strategic objective in the tourism planning process. A greater emphasis is placed on planning and implementation of sustainable measures through smart solutions…" (p. 4).

With the aforementioned examples, the need of a systemic perspective of smart tourism, mentioned in the literature review, has been confirmed. In general, the observed experiences indicate a partial implementation, apparently lacking a holistic perspective and, therefore, with a perspective positioned at the lower level of interaction, mostly at applied level if figure 2 is observed. This is in line with Dos Santos Júnior *et al.* (2017, 362), when they state that: "The literature features many studies focused mainly on the relevant use of ICTs as a resource for innovation or smart tourism, but there is shortage of other researches explaining the phenomenon in a systemic and integrated manner", which reflects a critical evaluation. Retaking figure 2 again, the

creation of a STD usually follows a bottom-up process which lacks of a well-defined strategic-relational level in its early stages, which should be reverted.

Gretzel *et al.*, (2015b) mentioned a number of examples of particular actions implemented in cities/places such as Barcelona (Spain), Brisbane (Australia), Amsterdam (The Netherlands), Seoul and Jeju Island (South Korea), and Sunmoon Lake (Taiwan), although recognizing that "all these efforts are pieces of larger, coordinated efforts and strategic investments to foster innovation, quality of life and sustainability through enriching physical infrastructure with data within the context of specific destinations" (pp. 180-181).

In the case of Dubai, for instance, it has been recognized that "there is a need to integrate the various components of the Smart Dubai framework (of which Smart Tourism is a subset)", having led to the proposal of a Smart Tourism Dynamic Responsive System (Sajid Khan *et al.*, 2017). The case of Marbella (Spain), however, seems that is moving in this direction (Dos Santos Júnior, 2017), although Femenia-Serra and Perea-Medina (2016), in their analysis of three potential Spanish Smart Tourism Destinations (including Marbella together with Málaga and Alicante) conclude that the lack of a general approach integrating all the actions is the main deficiency detected in the studied destinations.

With this in mind, the design of tourism destinations should not be based on harnessing the ICTs proliferation only, but, more importantly, on the need for balancing all the beneficiaries - internal publics (residents, local people) and external ones (visitors in one single word, both excursionists and tourists)- through the paradigm of "smartness", that, in the search for a more sustainable tourism industry, guides people's living conditions.

In terms of research contribution, this study has enriched the conceptualization of "smartness" that intersects destination development and sustainable tourism. Future studies should focus on this intertwined nature, examining the experience of smart destinations that, under a holistic approach (upper level of interaction), links with the promotion of a sustainable tourism. In addition, a more focused research approach would be advisable in order to get deeper and more specific insights into each component of smartness.

Although the development of the smart tourism approach is clearly supporting the efforts towards a more sustainable tourism industry, acting as a decisive driver, bridging a number of gaps (revealed during the literature review) would be recommended for a full exploitation of that intersection:

- The need to move from a focus based on particular technological solutions to particular problems, to a more global and long-term perspective on how the data-driven logic of smartness can help to tackle sustainability issues in destinations (growth and over-tourism, for instance). Consequently, a systemic and strategic approach for a proper articulation of smart tools in line with sustainability goals is evidenced as part of the future research agenda in this field.
- Until now, the intersection under study has been dominated by economic (cost savings, reputation, new business opportunities) and environmental (efficiency in water/energy consumption, reduction of greenhouse gases emissions) matters. This bias should be balanced, putting in the spotlight of the research agenda the social dimension of sustainability. The smart tourism approach has also a significant potential to contribute to the preservation of local heritage, way of living and culture in general, connecting its capabilities with the social components of smart people, smart mobility and smart living.
- Even in its environmental dimension, a new big challenge for tourism organizations is still absent in the academic literature: the insertion of tourism into the emergent paradigm of circular economy. The whole economy is in a transition process from the linear to the circular paradigm, and the tourism industry cannot be strange of this unavoidable shift, whose application will contribute to a more sustainable tourism industry. In that transition, the technological power of the smart tourism approach has, undoubtedly, a significant role to play. This topic, that requires a strategic vision and a long-term planning for destinations, can be positioned as another major branch in the research agenda in this field.

The evolution of Smart Destinations has to be understood as a process, which is moving from the implementation of partial applications and solutions based on tech developments, to a more systemic approach under which the multiple pieces of the puzzle fits and make sense within a shared strategic vision of the destination and a long term plan: without a managing body able to implement a strategic management system, encouraging planning and coordination, technologies cannot deliver a sustainable competitive advantage. And, as Gajdosik (2017) concluded, this requires the integration of knowledge from various disciplines, "in particular from information systems, management and marketing, spatial planning, destination management as well as quantitative and qualitative data analysis" (p. 224).

In spite of its critical evaluation of the literature and its practical implications, this paper is not exempt from limitations. Although the completeness in the collection of experiences in a so vast and dynamic field is a utopia (this is why we have never aimed to do that in this work), it is honest to recognize that the speed of technological evolution prevents to present a set of initiatives fully updated, together with their outputs. In connection to this fact, the establishment of a complete research agenda, based on the real gaps detected in the industry, gets harder and, in its most genuine sense, is still pending to do. Nevertheless, some lines have been already revealed in this piece of work.

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La creazione di valore tra sostenibilità ed economia circolare: il ruolo della rivitalizzazione di siti produttivi storici

VINCENZO FORMISANO* MARIA FEDELE•

Abstract

Obiettivi. *L'obiettivo di questo lavoro è quello di analizzare la creazione di valore attraverso lo sviluppo sostenibile e un modello di business fondato sui principi dell'economia circolare.*

Metodologia. *Il lavoro si basa sul metodo qualitativo/esplorativo del caso di studio. Un'impresa italiana di medie dimensioni è stata selezionata sulla base delle sue performance e risultati positivi raggiunti anche attraverso un modello di business incentrato sull'economia circolare e sullo sviluppo sostenibile. Lo studio è stato condotto attraverso un'analisi dei dati secondari e un'intervista approfondita con l'amministratore delegato, con l'obiettivo di evidenziare la rilevanza delle attività sostenibili e strategie circolari come la rivitalizzazione di siti produttivi nella creazione di valore dell'impresa.*

Risultati. *I risultati mostrano che l'impresa analizzata, attraverso strategie fondate sui principi dell'economia circolare, l'utilizzo nel processo produttivo di ceneri derivanti dagli scarti degli inceneritori e la riapertura di impianti storici in zone colpite dalla crisi, è riuscita a generare valore in termini ambientali, sociali e reddituali. L'impresa, infatti, a seguito di tali strategie, ha incrementato il fatturato utilizzando materiali per la produzione a costo zero che però hanno consentito la creazione di un prodotto distintivo a livello qualitativo e competitivo, ha preservato e creato circa 500 posti di lavoro altamente qualificati, ha ridotto l'impatto dello smaltimento dei rifiuti sull'ambiente.*

Limiti della ricerca. *L'analisi di un caso di studio singolo non permette di generalizzare i risultati ottenuti. Inoltre, a causa della recente costituzione dell'organizzazione presa in esame, l'analisi dei dati è stata condotta su un orizzonte temporale ridotto.*

Implicazioni pratiche. *I risultati del lavoro suggeriscono l'adozione di strategie basate sulla sostenibilità evidenziando i risultati raggiungibili attraverso l'implementazione di modelli di business basati sulla realizzazione dei principi dell'economia circolare.*

Originalità del lavoro. *Nonostante la letteratura sulla sostenibilità aziendale e l'economia circolare si stia arricchendo di contributi negli ultimi anni, la maggior parte sono focalizzati sui mercati emergenti. Questo lavoro offre un contributo analizzando una realtà manifatturiera italiana che adotta un innovativo modello di business, perché associa alla filiera circolare un processo produttivo che comprende anche delle materie prime derivanti dagli scarti dei termovalorizzatori che trattano i rifiuti urbani ottenendo un output dotato di performance qualitative elevate.*

Parole chiave: *economia circolare; caso di studio; prodotti circolari, sostenibilità; analisi SWOT; industria manifatturiera.*

Objectives: *The aim of this work is to analyze the business' value creation through the sustainable development and a business model based on the principles of the circular economy.*

Methodology: *The work is based on the qualitative / exploratory method of the case study. A medium-sized Italian enterprise has been selected on the basis of its performance and positive results also achieved through a business model focused on the circular economy and sustainable development. The study was conducted through the analysis of secondary data and an in-depth interview with the CEO, with the aim of highlighting the relevance of sustainable activities and circular strategies like the revitalization of production sites for the company's value creation.*

Findings: *The results show that the analyzed company, through strategies based on the principles of the circular economy, the use in the production process of ashes deriving from incinerator waste and the reopening of historic plants in areas hit by the crisis, was able to generate value in environmental, social and income terms. In fact, because of these strategies, the company has increased its turnover by using materials for production at zero cost, allowing the creation of a distinctive product at a qualitative and competitive level, preserving and creating about 500 highly qualified jobs, and reducing the impact of waste disposal on the environment.*

Research limits: *The analysis of a single case study does not allow generalizing the results obtained. Furthermore, due to the recent establishment of the organization under examination, the analysis of the data was conducted on a short time horizon.*

Practical implications: *The results of the work suggest the adoption of strategies based on sustainability, highlighting the results that can be achieved through the implementation of business models based on the application of the circular economy principles.*

Originality of the study: *Although the literature on corporate sustainability and circular economy is enriching with many contributions in recent years, most of them are focused on emerging markets. This work offers a contribution by analyzing an Italian manufacturing reality that adopts an innovative business model, because it associates with the circular supply chain a production process that also includes raw materials deriving from waste incinerator plants that treat urban waste obtaining an output with high qualitative performance.*

Key words: *circular economy, case study, circular products; sustainability; SWOT analysis; manufacturing industry*

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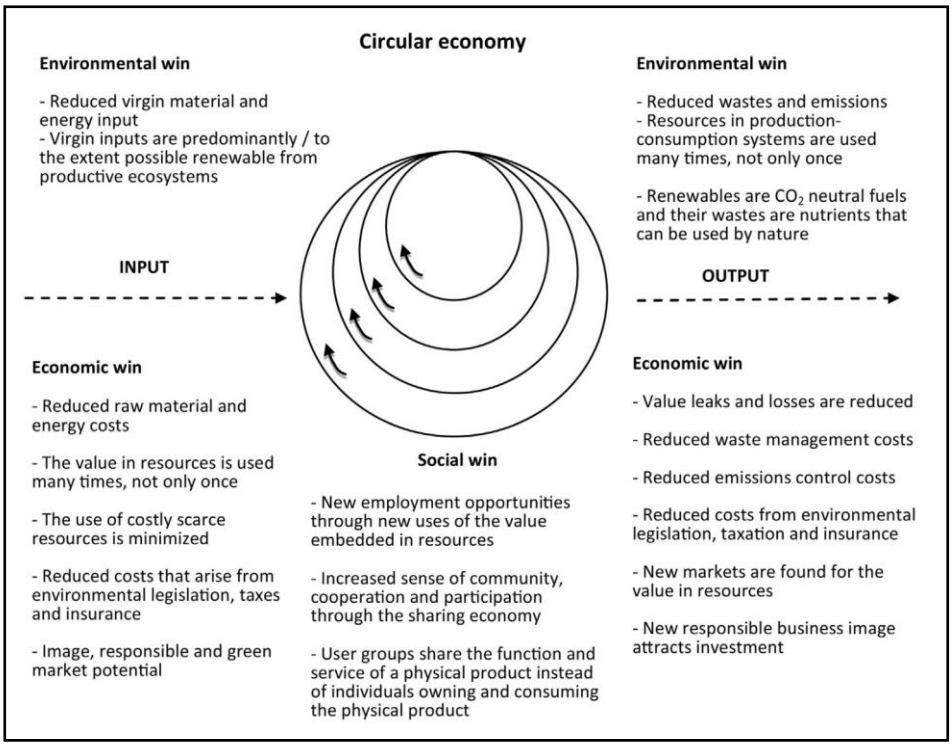
Introduzione

Nell'ambito della ricca letteratura sul tema, la sostenibilità (Hardin, 1968, 1998; Brundtland, 1988; Golinelli, Volpe, 2012) è considerata una leva strategica in grado di creare valore perché facilita l'ingresso in nuovi mercati, favorisce l'assunzione di personale adeguato e particolarmente qualificato, accresce la fidelizzazione della clientela, la reputazione aziendale tra gli stakeholder e una maggiore efficienza per quanto riguarda l'utilizzo delle risorse nei processi produttivi. Tuttavia, per una completa diffusione della sostenibilità all'interno di un'azienda, è necessario che essa sia radicata nella cultura organizzativa, in modo che valori e credenze condivise, anche dai dipendenti, facciano parte della routine e dell'abitudine della vita aziendale (Martins *et al.*, 2003; Opoku, 2015; Fedele, 2018). Prendendo in considerazione la concettualizzazione di Custance e Hiller (1998), modellizzata e definita "Three-ring circus model of sustainability" da Levett (1998), che la fa evolvere nel "Russian doll model of sustainability", e condividendo il pensiero di Kalva (2017), l'impresa moderna deve operare tenendo presente che gli obiettivi economici, ambientali e sociali sono strettamente correlati. Tali obiettivi avendo uguale importanza e analizzati secondo una visione sistemica (Golinelli, 2008; 2009; Barile, 2008; 2009; Barile e Saviano, 2008; 2018), implicano l'assenza di una relazione gerarchica e la necessità di ricercare una sorta di equilibrio tra di essi. Inoltre, se associati a quelli etici rappresentano gli aspetti centrali oggetto di diversi studi sul ruolo dell'impresa nella società, perché determinano conseguenze dirette sulle prestazioni aziendali (Burchell e Cook, 2006). Negli ultimi decenni la sostenibilità ha trasformato il modo con cui le imprese competono sul mercato, applicando metodi di produzione e di consumo più accettabili. Ciò è avvenuto e avviene tutt'oggi attraverso un lungo percorso di transizione che, coinvolgendo diverse categorie di stakeholder, ha determinato la nascita di nuovi prodotti, servizi e modelli di business con ripercussioni anche sulle percezioni e le scelte dei consumatori (Markard *et al.*, 2012; Frey, 2013; Bartolacci *et al.*, 2016; Korhonen *et al.*, 2018). Come specificato da Loorbach (2010), le transizioni dei sistemi sociali - che sono considerate come dinamica evolutiva dei sistemi complessi (Golinelli, 2008; Grin *et al.*, 2009; Barile *et al.*, 2013) - avvengono anche sulla base di azioni individuali come risposta a mutamenti che si verificano nel contesto di riferimento Chiaramente, per raggiungere l'obiettivo della sostenibilità è essenziale in primis il coinvolgimento del management aziendale che deve pianificare una specifica dinamica evolutiva, con ripercussioni a livello sociale, anche attraverso la creazione di reti informali per accelerare i processi innovativi (Smith *et al.*, 2005; Siano *et al.*, 2006). Per raggiungere l'ottimizzazione degli obiettivi di sviluppo sostenibile un ruolo rilevante è assunto dall'economia circolare in grado di aumentare la competitività delle imprese che la attuano, generando contemporaneamente benefici concreti per il contesto socio-ambientale di riferimento (Calabrese *et al.*, 2012; Ghisellini *et al.*, 2016; Lacy *et al.*, 2016; Lieder e Rashid, 2016; Geissdoerfer *et al.*, 2017; 2018; Formisano *et al.*, 2018; Rizzi e Annunziata, 2018; Pieroni *et al.*, 2019).

Fig. 1: L'economia circolre per lo sviluppo sostenibile. Il potenziale win-win-win dell'economia circolare



Fonte: Korhonen *et al.*, 2018

La relazione tra economia circolare e sostenibilità è particolarmente evidente quando si fa riferimento all'impresa manifatturiera che deve operare anche rispettando quanto previsto dalle normative in materia di tutela ambientale, affrontando le problematiche inerenti la volatilità dei prezzi delle risorse critiche e quelle relative al loro accesso e approvvigionamento. Per Lathi *et al.* (2018), "implementing the circular economy implies forming new markets, with sustainability at the core. These markets can be understood as early-stage business environments where companies offer and compete with a new type of business model based on seeking profits from sustainable alternatives". È la sostenibilità, dunque, l'elemento fondante dei modelli circolari. Il pensiero circolare ha, come prerogativa, la creazione di paradigmi sostenibili, nei quali l'azione economica incontra i bisogni umani senza compromettere l'ecosistema e la disponibilità delle risorse alle generazioni future. L'economia circolare, infatti, favorisce il raggiungimento di obiettivi di efficienza economica mediante la riduzione dei costi di approvvigionamento delle materie prime (Ellen MacArthur Foundation, 2013; Govindan e Hasanagic, 2018) e di produzione (Stahel, 2010), offre nuove opportunità di business, un'offerta diversificata, una maggiore fidelizzazione della clientela e tutela del brand (Ellen MacArthur Foundation, 2015), risponde alla sfida globale inerente alla scarsità di risorse critiche (Lieder, Rashid, 2016; Govindan e Hasanagic, 2018; Murray *et al.*, 2018). Risorse che sono considerate tali se "supply is concentrated in one country or could be restricted by a few corporate interests, and because they are important economically or for national security" (Ashby, 2012). L'economia circolare implica, in particolare, un cambiamento radicale dei tradizionali modelli di business con dirette implicazioni sui processi di approvvigionamento e di produzione, sulla progettazione di tecnologie innovative, sulla definizione della struttura organizzativa, sulle relazioni con gli stakeholder esterni e sulle abitudini di acquisto dei consumatori. Come rilevato dall'analisi delle letteratura esistente, gli studi sull'economia circolare sono associati alla scarsità di risorse, ai benefici economici che genera, alle conseguenze dell'attività industriale sull'ambiente naturale per effetto dei rifiuti generati dall'economia lineare (Murray *et al.*, 2017), e su tali fattori anche in combinazione tra di loro. Diversi sono i motivi alla base del crescente interesse verso l'implementazione dell'economia circolare: il degrado ambientale causato prevalentemente da un indiscriminato sfruttamento delle risorse naturali, i problemi di

approvvigionamento delle risorse legati a situazioni politiche instabili, specifiche politiche nazionali e internazionali volte a fronteggiare situazioni di degrado ambientale, il progresso tecnologico che favorisce l'uso più efficiente delle risorse (Jones, Comfort, 2018). Il modello di business circolare (Rizos *et al.*, 2016; Linder e Williander, 2017; Bressanelli *et al.*, 2018) è strettamente correlato a quello dell'Industria 4.0 (Bressanelli *et al.*, 2018; de Sousa Jabbour *et al.*, 2018b). La diffusione di tecnologie innovative, dell'information technology (IT), dei big data e l'assunzione di decisioni basate sui dati, possono essere considerate attività che supportano la diffusione dell'economia circolare (Kamp, Parry, 2017; Pagoropoulos *et al.*, 2017; Bressanelli *et al.*, 2018; de Sousa Jabbour, 2018b; Garcia-Muiña *et al.* 2018; Müller *et al.*, 2018; Tseng *et al.*, 2018). In letteratura il paradigma dell'economia circolare è analizzato prevalentemente in ottica di riduzione dei rifiuti, di rivitalizzazione dei prodotti giunti al termine del loro ciclo di vita (a titolo esemplificativo si citano la plastica, le risorse idriche, l'acciaio, il cibo, gli abiti, gli apparecchi elettronici, ecc.), della rilevanza di un costante flusso circolare delle risorse a livello intra-sistemico per ridurre la quantità di emissioni, scarti e rifiuti immessi nell'ambiente, su come affrontare il problema dell'esaurimento delle risorse non rinnovabili (Srivastava, 2007; Amoyaw-Osei e Agyekum, 2011; Haas *et al.*, 2015; Blomsma e Brennan, 2017; Stewart e Niero, 2018). Il lavoro di Botezat *et al.* (2018), evidenzia come le economie dell'Unione Europea siano state le prime ad adottare i principi dell'economia circolare, affrontando una sfida ardua e ambiziosa finalizzata alla crescita economica globale. Tuttavia, la maggior parte degli studi sul tema sono stati condotti con riferimento ai mercati orientali (Geng e Doberstein, 2008; Geng *et al.*, 2009; Park *et al.*, 2010; Mathews e Tan, 2011; Liu e Bai, 2014; Singh *et al.*, 2018; Agyemang *et al.*, 2019; Kumar *et al.*, 2019). E' stata riscontrata, anche, una conoscenza ancora scarsa dell'applicazione dei principi dell'economia circolare nei mercati europei e in particolare nelle PMI italiane (Ranta *et al.*, 2018). Inoltre, è emersa l'esigenza di reperire informazioni inerenti peculiari modalità di implementazione del modello economico circolare per un duplice ordine di motivi: per poter effettuare dei collegamenti e rilevare dei fattori di omogeneità al fine di eventuali interazioni (de Jesus, Mendonça, 2018); perché in letteratura sono stati riscontrati studi che si sono soffermati soprattutto sui numerosi fattori che a livello europeo hanno ostacolato la transizione verso un modello economico circolare (Kirchherr *et al.*, 2018).

Sulla base di tali presupposti, l'obiettivo di questo lavoro è quello di analizzare la creazione di valore attraverso lo sviluppo sostenibile e un modello di business fondato sui principi dell'economia circolare in ambito italiano al fine di rispondere alle seguenti domande di ricerca:

a) come si possono applicare i principi dell'economia circolare in una PMI italiana?
b) quali sono i vantaggi generati da un peculiare modello economico circolare per una PMI italiana e per i suoi stakeholder?

Pertanto, per rispondere a tali domande, questo lavoro si fonda sull'analisi di un caso di studio (Yin, 2009) relativo a un'azienda manifatturiera italiana che ha implementato un innovativo modello di business circolare in quanto associa alla filiera circolare sia un un processo di produzione peculiare, sia il rilancio di siti produttivi storici. In particolare, il focus è incentrato sulle strategie di un modello di business che prevede la creazione di un "prodotto circolare" in grado di generare benefici economici per l'azienda e positive ricadute a livello socio-ambientale. Infatti, attraverso l'analisi del caso selezionato, si intende evidenziare come una strategia di business improntata sull'economia circolare possa generare benefici endogeni ed esogeni, con importanti ricadute anche a livello sociale. In tal modo è possibile comprendere un fenomeno complesso ed esplorare le caratteristiche dettagliate di un'organizzazione che si distingue nel settore di appartenenza e nel contesto di riferimento per l'apertura verso percorsi di crescita e sviluppo del tutto innovativi.

Lo studio è strutturato come segue. Inizialmente è stata effettuata una review della letteratura interdisciplinare sulle motivazioni alla base della transizione dall'economia lineare a quella circolare, resa necessaria per inquadrare un paradigma che è stato poco analizzato in ottica manageriale (Lahti *et al.*, 2018). Successivamente, viene descritto il caso di un'azienda che attua, come suddetto, i principi dell'economia circolare in modo peculiare e che seppur molto "giovane" ha già riscontrato l'approvazione da parte del mercato e si distingue nel contesto di operatività per

le ricadute sociali che genera. Infine, dopo le considerazioni conclusive e le implicazioni manageriali, i limiti della ricerca e i suggerimenti per la ricerca futura chiuderanno il lavoro.

1. Dall'economia lineare all'economia circolare

L'economia circolare trae origine dagli studi degli economisti classici e in particolare da Malthus (1798), il quale evidenziò come la scarsità delle risorse rendesse necessari cambiamenti radicali per evitare che la crescita demografica potesse determinare l'esaurimento delle risorse naturali e una notevole perdita di benessere per la popolazione mondiale. Tuttavia, il dibattito vero e proprio sull'opportunità di un nuovo modello economico sostenibile iniziò in un'epoca più recente quando furono analizzati gli effetti negativi che la scarsità delle risorse avrebbero generato sulla crescita economica, evidenziando come la visione degli economisti riguardo lo sfruttamento delle risorse è cambiata nel tempo (Barnett e Morse, 1963). Successivamente il Club di Roma, commissionò ad un team di analisti del Massachusetts Institute of Technology (MIT) l'analisi delle problematiche legate al consumo delle risorse terrestri, attraverso l'utilizzo del modello World3. Questo studio, dal titolo "Limits to Growth" (Meadows *et al.*, 1972), puntava ad esaminare le interazioni presenti tra cinque sub-sistemi del più ampio sistema naturale, ovvero popolazione, produzione di cibo, produzione industriale, inquinamento e consumo di risorse non rinnovabili (Turner, 2008). Una delle principali sfide che "Limits to Growth" cercava di evidenziare consisteva nel proporre soluzioni ai problemi causati dalla linear economy attraverso la visione sistemica della realtà. Ovvero, considerando il sistema economico come un insieme di sub-sistemi dove i problemi dei singoli settori (come per esempio quello energetico o dell'agricoltura), possono essere risolti attraverso l'implementazione di soluzioni in grado di soddisfare molteplici condizioni e capaci di indicare una strada diversa da quella rappresentata dalla simulazione World3 (Meadows *et al.*, 1972). Il termine "economia circolare", però è stato coniato da Pearce e Turner (1990) i quali evidenziando le criticità del modello lineare hanno proposto un modello alternativo di tipo chiuso. Può considerarsi rilevante, ai fini della formazione del pensiero circolare, anche l'aggiornamento avvenuto trent'anni dopo quando, con la pubblicazione de "Limits to Growth: The 30-Year Update" gli autori hanno ipotizzato una visione della realtà ancora più pessimistica rispetto a quella descritta nella versione iniziale (Meadows *et al.*, 2004). L'economia circolare, lungo il processo di formazione delle idee circolari, ha condiviso molti principi del modello definito "Blue Economy" (Pauli, 2010) che prevede una crescita economica, e la creazione di figure professionali altamente specializzate, attraverso l'impiego sostenibile delle risorse provenienti dall'oceano, mediante l'utilizzo di tecnologie capaci di far fronte all'ingente domanda di cibo e attività pur senza nuocere sull'ecosistema marino. Il modello economico di tipo circolare applicato in un contesto manifatturiero sostenibile si fonda su sei principi, definiti 6R (riutilizzare, riciclare, riprogettare, rigenerare, ridurre e recuperare), applicabili in diversi stadi del ciclo di vita dei prodotti; essi rappresentano gli elementi essenziali che consentono di perseguire la crescita economica, la tutela ambientale e benefici per il contesto sociale (Jawahir e Bradley, 2016). Si tratta di un'evoluzione delle 3R (riduzione, riutilizzo e riciclo) che tradizionalmente sono stati considerati i principi fondanti di un approccio economico chiuso e che a loro volta hanno avuto origine dalla lean manufacturing (incentrata sulla riduzione dell'uso delle risorse per massimizzare l'efficienza) degli anni '90. Tuttavia, è bene precisare che sul numero di principi in letteratura è stata evidenziata una numerosità piuttosto eterogenea che oscilla da 1 a 10 in funzione della prospettiva presa in considerazione (Reike *et al.*, 2018). Per offrire una consulenza alle aziende al fine di accelerare la transizione dall'economia lineare a quella circolare, nel 2010, è stata costituita "The Ellen McArthur Foundation". Secondo quanto indicato dalla Fondazione, la circolarità può essere sviluppata solo applicando un pensiero sistemico (Genovese *et al.*, 2017) per ripensare la catena del valore di alcuni settori che endemicamente utilizzano il modello lineare. Pensiero sistemico che si concretizza mediante interazioni e processi innovativi intersettoriali, finalizzati a ripensare il modello economico adottato attraverso il coinvolgimento di diverse categorie di stakeholders ed

evitare che l'output della filiera produttiva diventi un rifiuto. In pratica, la Fondazione sostiene che è necessario un impegno globale per cambiare le modalità produttive, di utilizzo e riutilizzo/riciclo dei prodotti per evitare che venga disperso nell'ambiente. Ciò implica l'attuazione di una transizione da processi economici lineari, fondati sulla sequenza "prendere, fabbricare, usare e smaltire" che non considerano l'incidenza dello sviluppo economico sull'ambiente e sul capitale sociale, a modelli circolari che prevedono il recupero, riutilizzo e riciclo delle risorse mediante la combinazione di una varietà di processi differenti come manutenzione, riparazione, riutilizzo, ristrutturazione, rigenerazione e riciclaggio con la finalità di trasformare il rifiuto in risorsa (Russell *et al.*, 2005; Mathews e Tan, 2011; Geng *et al.*, 2016; Sauvéa *et al.*, 2016; Blomsma e Brennan, 2017; Kirchherr *et al.*, 2017; Masi *et al.*, 2017). Il termine economia circolare è stato considerato come un concetto ad "ombrello" (Hirsch e Levin, 1999) perché, avendo una natura molto ampia, ingloba diversi fenomeni correlati tra loro. Infatti, per Blomsma e Brennan (2017), comprende un'ampia gamma di strategie di gestione dei rifiuti e delle risorse per estenderne la vita utile e creare valore al fine di evitare situazioni di perdita/distruzione di valore. La possibilità di ricorrere all'uso di prodotti sostituti derivanti da alternative rinnovabili può influire sia sull'intensità della concorrenza e in particolar modo sul potere contrattuale dei produttori in relazione ai rapporti con i fornitori (Porter, 1980), sia sulla dipendenza dalle risorse esterne restringendo, di fatto, l'ampiezza dell'ambiente transazionale. Per soddisfare i requisiti richiesti dai modelli di business circolari è importante monitorare, valutare ed eventualmente riconfigurare la dotazione di risorse disponibili in portafoglio per conseguire un vantaggio competitivo sostenibile (Wernerfelt, 1984; Barney, 1991; 2001; Helfat e Peteraf, 2003; Sirmon *et al.*, 2007). Blomsma e Brennan (2017), hanno definito l'economia circolare come "un approccio emergente intorno ai rifiuti e alla gestione delle risorse che mira a offrire un'alternativa al take-make-dispose lineare prevalente applicato, promuovendo pratiche di riciclaggio dei rifiuti e delle risorse". Tuttavia, non è riscontrabile in letteratura una specifica e condivisa definizione sul tema (tabella 1) per la presenza di distinti ambiti di ricerca (Yuan *et al.*, 2008; Lieder e Rashid, 2016; Kirchherr *et al.*, 2017; Masi, 2017; Govindan e Hasanagic, 2018). Per esempio, la Commissione Europea, tra le principali strategie che possono consentire i diciassette obiettivi per lo sviluppo sostenibile contenuti in Agenda 2030, ha descritto l'economia circolare come un incentivo alla modernizzazione sostenibile e di lungo termine dell'economia europea, poiché crea posti di lavoro altamente specializzati, opportunità di integrazione sociale e incrementa la competitività (Commissione Europea, 2016). Come riscontrato analizzando la letteratura, la definizione più ricorrente è quella della Ellen MacArthur Foundation (2012) che qualifica l'economia circolare come un "system restorative and regenerative by design, which aims to maintain products, components and materials at their highest utility and value".

Tab. 1: Varietà di definizioni sull'economia circolare

Autori	Definizioni
Yuan *et al.*, 2006	"Although there is no commonly accepted definition of circular economy so far, the core of circular economy is the circular (closed) flow of materials and the use of raw materials and energy through multiple phases"
Zhijun, Nailing, 2007	"is a mode of economic development based on ecological circulation of natural materials, requires compliance with ecological laws and sound utilization of natural resources to achieve economic development. It is, essentially, an ecological economy that follows the principles of ''reducing re source use, reusing, and recycling'', with the objectives of reducing the resources that enter the production process, effecting multiple use of the same resources in different ways, and reusing waste from one facility as a resource for other facilities"
Geng *et al.*, 2008	"an economy based on a "spiral-loop system" that minimises matter, energy-flow and environmental deterioration without restricting economic growth or social and technical progress"
Geng *et al.*, 2009	"The concept of circular economy has the same essence as industrial ecology, implying a closed-loop of materials, energy and waste flows"
Chen, 2009	"To solve the contradiction of limited resources and the increased consuming desire of human being[s], and to make use of natural resources rationally to achieve sustainable development, the circular economic development mode follows the pattern of ecological circulation and is based on the recycling of material resources"
Mathews *et al.*, 2011	"From being an exclusively ecological concept it is becoming a business and competitive concept, where benefits are experienced not by firms acting on their own so much as in concert with each other, reducing their collective costs and making systemic gains that reduce the ecological toll of industrial activities"

Park *et al.*, 2010	"The Chinese circular economy policy originated with the IE policy and is built upon the concept of industrial supply chain loop closing"
Li, Yu, 2011	"In an attempt to mitigate these difficulties, however, China's general strategy is one of sustainable development - promoting comprehensive resource conservation and efficient utilization, and clean production: the circular economic model"
Zhu *et al.*, 2010	"Circular Economy promotes continuous economic development without posing significant environmental and resource challenges"
Franklin-Johnson *et al.*, 2016	"The central of circular economy is the circular (closed) flow of materials and the use of raw materials and energy through multiple phases"
Ghisellini *et al.*, 2016	"a way to overcome the current production and consumption model based on continuous growth and increasing resource throughput"
Hobson, 2016	"[The CE is] an industrial system that is restorative or regenerative by intention and design . . . [and] aims for the elimination of waste through the superior design of materials, products, systems and business models."
Lieder, Rashid, 2016	"an economy which is environmentally and economically regenerative"
Singh, Ordonez, 2016	"Is an economic strategy that suggests innovative ways to transform the current predominantly linear system of consumption into a circular one, while achieving economic sustainability with much needed material saving".
Sauvé *et al.* 2016	"Production and consumption of goods through closed loop material flowsthatinternalize environmental externalities linked to virgin resource extraction and the generation of waste (including pollution)"
Stahel, 2016	"to maximize value at each point in a product's life"
Moreau *et al.* 2017	" Is a continuous positive development cycle that preserves and enhances natural capital, optimizes resource yields, and minimizes system risks by managing finite stocks and renewable flows"
Jakhar *et al.*, 2018	"Circular economy aims to build an economic system - which is restorative and generative in nature"
Murray *et al.*, 2017	"The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being."
Zink, Geyer, 2017	"The core of the circular economy refers to three activities: reuse at the product level (such as 'repair' or 'refurbishment'); reuse at the component level (e.g., 'remanufacturing'); and reuse at the material level ('recycling')"
De Jesus, Mendonça, 2018	"a multidimensional, dynamic, integrative approach, promoting a reformed socio-technical template for carrying out economic development, in an environmentally sustainable way, by re-matching, re-balancing and re-wiring industrial processes and consumption habits into a new usage-production closed-loop system"
Korhonen *et al.*, 2018a	"Is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and Energy throughput flow. This is done by using cyclical materials flows, renewable energy sources and cascading1-type energy flows. Successful circular economy contributes to all the three dimensions of sustainable development"
Korhonen *et al.*, 2018b	"Is a sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. Circular economy promotes high value material cycles alongside more traditional recycling and develops systems approaches to the cooperation of producers, consumers and other societal actors in sustainable development work"
Ranta *et al.*, 2018	Is "a sustainable alternative to the current linear economic model"

Fonte: elaborazione propria

Per rendere efficace la circolarità è necessario condividere la strategia aziendale con attori della supply chain e della complessiva rete industriale, che appartengono anche a settori diversi, sulla base di relazioni cooperative basate sulla fiducia reciproca, sulla condivisione di informazioni (Jarillo, 1988; Borch, Arthur, 1995) e rimodulando, di fatto, il modello decisionale della triple bottom line (Elkington, 1994; 1997). Ciò è necessario anche perché, come specificato da Lahti et al (2018) le aziende che applicano un modello di business circolare non potendo basarsi su dati storici hanno difficoltà a formulare previsioni riguardanti il futuro, devono applicare innovativi modelli di business e introdurre innovazioni tecnologiche radicali, essere molto flessibili e pronte a modificare completamente la propria catena del valore per adeguarsi alle esigenze del mercato e del contesto sociale. Tutto questo implica sia ingenti investimenti per l'azienda in questione e per gli altri stakeholder della rete industriale che ne condividono la strategia, sia il livello dei rischi assunti. Per attuare efficacemente un processo circolare, pertanto, è essenziale un'elevata consonanza collaborativa e strutturale tra l'azienda e i partner che fanno parte della struttura ampliata (Golinelli, 2008). Queste motivazioni sono, però, alla base delle ragioni per cui in molti casi viene ostacolata la transizione verso la circolarità (Kortmann, Piller, 2016), soprattutto quando l'azienda in questione è

una PMI che per natura è dotata di risorse limitate. Analizzando la letteratura sul tema, sono stati rilevati diversi punti di forza interni e opportunità esterne che favoriscono l'adozione e l'implementazione di un approccio economico di tipo circolare anche agendo in modo proattivo, seppur condizionati dalle caratteristiche del contesto competitivo (Geng e Doberstein, 2008; Mathews e Tan, 2011; Moorthy *et al.*, 2012; Bastein *et al.*, 2013; Benton *et al.*, 2015; Rizos *et al.*, 2015, 2016; Van Eijk, 2015; Masi *et al.*, 2017; Ritzén, S.; Sandström, 2017; Wijkman e Skånberg, 2017; Winans *et al.*, 2017; de Jesus e Mendonça, 2018; Govindan e Hasanagic, 2018; Kirchherr *et al.*, 2018; Mangla *et al.*, 2018; Shahbazi *et al.*, 2018; Agyemang *et al.*, 2019; Ferronato, *et al.*, 2019; Kumar *et al.*, 2019):

- punti di forza interni:
  - performance economiche (aumento del fatturato, della redditività, della quota di mercato, del vantaggio competitivo) pur affrontando le sfide della tutela ambientale (Tseng *et al.*, 2008; Agyemang *et al.*, 2019);
  - consapevolezza dell'economia circolare per poterne promuovere l'adozione di pratiche in tal senso (Roxas e Coetzer, 2012; Singh *et al.*, 2017; de Jesus e Mendonça, 2018; Agyemang *et al.*, 2019);
  - riduzione dei costi di produzione (Stahel, 2010; Agyemang *et al.*, 2019);
  - efficienza delle risorse e produzione snella (Agyemang *et al.*, 2019);
  - catena di fornitura coinvolta e impegnata al fine di massimizzare la circolarità (Witjes, Lozano, 2016);
  - modello di business attento alla salvaguardia ambientale e implementazione di modelli di produzione e modelli di consumo sostenibili (Tripathi e Singh, 2016; Blomsma e Brennan, 2017; McKinsey e Company, 2017; Stec e Zwolinski, 2018; Agyemang *et al.*, 2019);
  - modelli di crescita del business sostenibili (Agyemang *et al.*, 2019);
  - tecnologie basate sui principi dell'Industria 4.0 (Bressanelli *et al.*, 2018; de Sousa Jabbour *et al.*, 2018b);
  - interazioni cooperative tra clienti e fornitori per migliorare le performance economico-ambientali (Zhu *et al.*, 2011; Mont *et al.*, 2017);
  - sicurezza ambientale e gestione dei rischi relativi a problemi di salute e sicurezza (Pringle *et al.*, 2016; Hazen *et al.*, 2017; Quina *et al.*, 2017; Jakhar *et al.*, 2018);
  - prodotti "circolari" di elevata qualità (Su *et al.*, 2013);
  - offerta diversificata e personalizzata (Agyemang *et al.*, 2019);
  - propensione all'innovazione (Ranta *et al.*, 2018) e all'eco-innovazione (Jakhar *et al.*, 2019);
  - politica manageriale finalizzata all'innovazione ambientale (Berrone *et al.*, 2013);
  - disponibilità di risorse tecnologiche (De Sousa Jabbour *et al.*, 2018a);
  - stabilità nell'implementazione di iniziative "circolari" (Agyemang *et al.*, 2019);
  - reputazione del marchio e diritto ad operare su tutti i mercati mondiali (Ellen MacArthur Foundation, 2015);
  - maggiore resilienza aziendale e riduzione dei rischi (Ghisellini *et al.*, 2016; Ünal e Shao, 2019);
- opportunità esterne:
  - normative specifiche atte a favorire e sostenere la transizione dal modello economico lineare a quello circolare (Moorthy *et al.*, 2012; Govindan e Hasanagic, 2018; Jakhar *et al.*, 2018; Agyemang *et al.*, 2019);
  - pressione competitiva internazionale (Porter e van der Linde, 1995; Bansal e Roth, 2000; Mont *et al.*, 2017; Agyemang *et al.*, 2019);
  - pressioni da parte dei consumatori (Agyemang *et al.*, 2019);
  - volatilità dei prezzi;
  - attuazione dei principi di responsabilità sociale (Esken *et al.*, 2018; Agyemang *et al.*, 2019);
  - crescente consapevolezza sociale e pressioni da parte degli stakeholder (Desrochers, 2008; Mathews e Tan, 2011);
  - supporto da parte dell'azienda capo-gruppo (McIntyre e Ortiz, 2015; Agyemang *et al.*,

2019);
- piattaforme web per le PMI finalizzate allo scambio di informazioni sulle migliori pratiche attuabili (Rizos *et al.*, 2015).

Inoltre, diversi studiosi hanno esplicitato tutta una serie di punti di debolezza interni e di minacce esterne che possono ostacolare l'applicazione di un modello di business circolare:

- punti di debolezza interni:
  - incapacità a sostenere elevati investimenti iniziali (Vanner, 2014; Mont *et al.*, 2017; Kirchherr *et al.*, 2018);
  - mancanza di esperienza sulle modalità di transizione dal modello economico lineare a quello circolare (Shahbazi *et al.*, 2016; Agyemang *et al.*, 2019);
  - mancanza di conoscenza/inconsapevolezza sui nuovi modelli di business e sul concetto di economia circolare, sui benefici e sui rischi che genera (Vanner, 2014; de Sousa Jabbour *et al.*, 2018; Agyemang *et al.*, 2019; Ferronato *et al.*, 2019);
  - resistenza al cambiamento da parte del management aziendale (Simpson *et al.*, 2004; Rizos *et al.*, 2015; Pheifer 2017; de Sousa Jabbour, 2018a; Kirchherr *et al.*, 2018);
  - costi operativi e vincoli finanziari (Kirchherr *et al.*, 2018; Agyemang *et al.*, 2019);
  - incapacità tecnica e tecnologica a progettare prodotti coerenti con i processi circolari (Rizos *et al.*, 2015; Mont *et al.*, 2017; Kirchherr *et al.*, 2018);
  - mancanza di informazinoi sul ciclo di vita dei prodott (Geng e Doberstein, 2008; Su *et al.*, 2013; de Sousa Jabbour *et al.*, 2018);
  - processo di apprendimento per l'attuazione della circolarità e rischi associati (Agyemang *et al.*, 2019);
  - mancanza e/o inaccessibilità a risorse organizzative e/o finanziarie (interne ed esterne (soggetti pubblici e privati) (Geng e Wu 2000; Van Eijk, 2015; Agyemang *et al.*, 2019);
  - fattibilità effettiva dell'implementazione di un modello economico circolare (Agyemang *et al.*, 2019);
  - qualità del prodotto finito che potrebbe essere percepito, dal mercato, di livello scadente (Agyemang *et al.*, 2019);
  - inutilizzabilità dei materiali per finalità rigenerative o produttive (Agyemang *et al.*, 2019);
  - assenza di specifiche unità aziendali preposte alla ricerca di vantaggi competitivi sostenibili;
  - difficoltà a interagire con altre imprese (Mont *et al.*, 2017);
- minacce esterne:
  - incertezza del mercato (Bakker *et al.*, 2014; Govindan e Hasanagic, 2018);
  - politiche governative anche di natura fiscale (Geng e Doberstein, 2008; Agyemang *et al.*, 2019);
  - oneri amministrativi (Rizos *et al.*, 2015);
  - livello della domanda di prodotti circolari, consapevolezza e fiducia del mercato verso tale tipologia di prodotti (Andersen, 2007; Mathews, Tan, 2011; Vanner *et al.*, 2014; Mont *et al.*, 2017; Ranta *et al.*, 2018);
  - mancanza di supporto tecnico da parte di professionisti, istituti di ricerca pubblici e altri stakeholder esterni per sviluppare nuove capacità tecniche, tecnologiche e manageriali (Agyemang *et al.*, 2019);
  - scarso coinvolgimento/disponibilità di enti istituzionali, comunità e organizzazioni finanziarie a predisporre programmi di partecipazione pubblica finalizzati all'attuazione dell'economia circolare (Geng, Doberstein, 2008; Mathews, Tan, 2011; Rizos *et al.*, 2015, Pheifer, 2017);
  - scarsa attività di sensibilizzazione, mediante workshop, convegni, newsletter, ecc., da parte degli enti istituzionali per la promozione dell'economia circolare (Geng, Doberstein, 2008);
  - mancanza di integrazione e complessità della supply chain (Boons, Lüdeke-Freund, 2013; Van Eijk, 2015; Linder, Williander, 2017);
  - barriere tecnologiche (Preston, 2012; Vanner *et al.*, 2014; Shahbazi *et al.*, 2016; Pheifer, 2017; Kirchherr *et al.*, 2018);

- barriere di mercato (Preston, 2012; Rizos *et al.*, 2015; Shahbazi *et al.*, 2016; Mont *et al.*, 2017; de Jesus, Mendonça, 2018; Kirchherr *et al.*, 2018)
- difficoltà ad accedere ad adeguate fonti di finanziamento (Rizos *et al.*, 2015);
- asimmetria informativa (Rizos *et al.*, 2015; Winans *et al.*, 2017);
- costi di transazione (Mont *et al.*, 2017).

Nonostante l'importanza attribuita dalla letteratura all'economia circolare nei processi aziendali, emergono ancora scarsi contributi, in particolar modo empirici, che possano mostrare soprattutto nelle PMI come i principi propri di tale modello economico possano essere applicati, quali sono le difficoltà riscontrate dalle imprese e quali i vantaggi ottenuti (de Jesus, Mendonça, 2018; Govindan, Hasanagic, 2018; Luthra, Mangla, 2018; Mangla *et al.*, 2018). In particolare, si percepisce l'esigenza di maggiori studi incentrati sul contesto europeo e soprattutto italiano, che presenta un tessuto imprenditoriale costituito prevalentemente da PMI e che si colloca al primo posto nella classifica europea riguardante l'indice complessivo di circolarità (Circular Economy Network, 2019). Tali studi consentirebbero una maggiore comprensione dei fattori comuni e delle differenze nell'implementazione dell'economia circolare in diverse aree geografiche per agevolare la transizione globale verso tale modello economico (Ghisellini *et al.*, 2016; Agyemang *et al.*, 2019).

2. Metodologia

L'approccio metodologico utilizzato in questo lavoro è di tipo esplorativo/qualitativo applicando il caso di studio singolo. La scelta di un metodo qualitativo è giustificata dal fatto che la ricerca sulle economia circolare nelle imprese è piuttosto recente e gli studi quantitativi sono ancora scarsi. Pertanto, a nostro avviso, in questa fase, lo scopo cognitivo è la comprensione, e non la spiegazione, basata sul criterio della rappresentazione sostanziale piuttosto che statistica, attraverso strumenti di cross-sensing meno vincolanti rispetto al questionario che consente al ricercatore di raccogliere dati di prima mano. D'altronde, il nostro interesse è volto a comprendere un fenomeno complesso (Voss, 2002) nel contesto di riferimento. Pertanto, il metodo dello studio di caso è considerato quello più adatto a esplorare il funzionamento dettagliato di un'impresa (Baines, Lightfoot, 2013). Seguendo la metodologia di Yin (2003), lo studio del caso è stato condotto seguendo un rigido protocollo di ricerca che comprende la progettazione del lavoro, la raccolta e l'analisi dei dati, la formalizzazione dei risultati. Dopo un campionamento teorico a livello nazionale (Patton, 2002), per rispondere in modo coerente alle domande di ricerca si è ritenuto opportuno selezionare la Saxa Gres SPA perché seppur "giovanissima" è un'organizzazione imprenditoriale che ha applicato un modello di business particolare e ha conseguito in breve tempo delle performance rilevanti. Si è optato di scegliere il caso singolo in quanto, la particolarità del modello di business dell'impresa selezionata non consentiva il confronto con altre organizzazioni imprenditoriali. A questo punto, sono stati reperiti i dati e le informazioni applicando metodi diversi. In primis abbiamo effettuato dei colloqui con l'amministratore delegato e fondatore di Saxa Gres SPA nonchè del progetto dell'economia circolare applicato alle ceramiche per interni ed esterni. Successivamente tale figura è stata sottoposta a un'intervista strutturata al fine di poter pervenire alla definizione di implicazioni critiche del modello di business applicato in azienda. D'altronde, l'Amministratore Delegato è considerato un profondo conoscitore della realtà oggetto di studio e degli aspetti relativi alla circolarità. Egli ci ha fornito informazioni generali e dettagliate sulle modalità organizzative e operative aziendali. I dati e le informazioni acquisite sono state triangolate attraverso l'intersezione con i dati secondari estratti da diversi documenti, come bilanci e report aziendali che ci sono stati forniti durante la visita che abbiamo effettuato in uno degli stabilimenti produttivi, sito web e report delle associazioni di categoria. Per garantire la validità interna, abbiamo usato protocolli per lo sviluppo e la formalizzazione del case study; per ottenere la validità esterna abbiamo usato la generalizzazione analitica basata su Yin (2009).

3. Caso di studio: Saxa Gres SPA

Saxa Gres è un'azienda, partecipata da fondi nazionali e internazionali, creata alla fine del 2013 con un duplice obiettivo: acquisire e riconvertire uno stabilimento produttivo in stato di crisi appartenente a una grande azienda storica della ceramica italiana (Marazzi) e avviare una innovativa filosofia produttiva ispirata ai principi dell'economia circolare sempre nel settore della ceramica. Il finanziamento dell'acquisto e del re-startup del sito produttivo, attualmente operante a pieno regime, è avvenuto, al di là delle tipiche modalità (capitale proprio e affidamento bancario), mediante l'emissione di due minibond interamente collocati presso primari investitori italiani e fondi di investimento stranieri. Con tali risorse finanziarie la struttura operativa è stata profondamente trasformata mediante l'implementazione di tecnologie produttive innovative basate sia sulla riqualificazione e valorizzazione di materiali inerti derivanti dai rifiuti urbani che vengono sottratti allo smaltimento e integrati nel prodotto, sia al fine di poter applicare i principi delle 6R dell'economia circolare al 100%. In tal modo l'Azienda è riuscita in poco tempo a ottenere una posizione altamente competitiva sul mercato. Sin dalla fase di avvio e in ottica di sostenibilità, inoltre, sono stati effettuati significativi investimenti per rendere ancora più efficienti i presidi ambientali di cui dispone lo stabilimento.In tal modo, è stata creata la più grande azienda che produce piastrelle e materiali per la pavimentazione, localizzata al di fuori dello storico distretto della ceramica di Sassuolo. L'avvio effettivo della produzione, destinata in outsourcing a grandi gruppi produttivi e distributivi del settore operanti sia a livello nazionale sia internazionale, è avvenuta nei primi mesi del 2017. La scelta di ricorrere al modello B2B è finalizzata ad assicurare maggiori margini operativi in tale settore e un più efficiente network di distribuzione. Tuttavia, la peculiarità distintiva dell'Azienda è riconducibile alla realizzazione, dopo una specifica fase di sperimentazione, di una linea di prodotti composti da un mix di gres porcellanato che include fino al 30% di materiali inerti provenienti da rifiuti urbani, realizzati in varie tipologie di spessori e appositamente pensati per le pavimentazioni urbane. Si tratta, dunque, di prodotti di nicchia e di alta gamma realizzati utilizzando materiali di scarto destinati alla discarica. Nello stabilimento riconvertito, dopo l'acquisizione di un ex impianto appartenente Ideal Standard (un'azienda produttrice di sanitari in ceramica che ha spostato la produzione in Est Europa), è stato realizzato un "Sanpietrino" in gres porcellanato che, pur riproducendo perfettamente le caratteristiche estetiche del basalto utilizzato per la pavimentazione delle strade dei centri storici, è tecnicamente più performante, in quanto più leggero, resistente, economico, di alta qualità e sostenibile dal punto di vista ambientale. Proprio attraverso la produzione in modo distintivo ed esclusivo di sanpietrini in gres, l'Azienda potrà entrare in un ulteriore mercato, al momento monopolio cinese. Sempre in tale unità produttiva la Saxa Gres sta studiando la possibilità di creare un impianto di digestione anaerobica per Frazione Organica del Rifiuto Solido Urbano (FORSU) insieme a una società multi-utility. Attraverso il biodigestore FORSU sarebbe possibile trattare 85.000 tonnellate e trasformarle in biogas, eventualmente utilizzabile sia per produrre un composto fertilizzante, sia per generare energia e calore per l'impianto con conseguenti benefici economici, dal momento che tale voce di costo, che incide per il 30% sui costi di produzione, potrebbe essere ridotta di circa il 20%. Per di più, ha un enorme potenziale dovuto alla elevata marginalità dei prodotti, dovuta al costo ridotto per la crescente domanda da parte di utilities che sono disposte a pagare pur di poter smaltire in sicurezza le ceneri. Tutti i prodotti aziendali sono graficamente e cromaticamente personalizzabili. Inoltre, grazie all'utilizzo delle ceneri derivanti da termovalorizzatori, possono essere certificati come Ecolabel e sfruttati con la massima premialità negli appalti pubblici, come previsto dalla nuova normativa comunitaria del Green Public Procurement (GPP), recepita anche in Italia. Proprio gli enti pubblici, come i Comuni, sono considerati ulteriori potenziali consumatori dei prodotti della Saxa Gres che si prestano ad essere utilizzati per le pavimentazioni delle strade urbane. Le caratteristiche peculiari di Saxa Gres le consentono, dunque, di sfruttare un notevole potenziale sui mercati europei e mondiali. Un'altra fonte di vantaggio competitivo aziendale è rappresentata dalla sua localizzazione prossima a un'ampia cava d'argilla di proprietà il cui utilizzo è determinante per il conseguimento di ulteriori vantaggi sui costi rispetto ai competitors del noto distretto della

ceramica di Sassuolo. I suddetti punti di forza verranno sfruttati anche nell'ambito di ulteriori due siti industriali recentemente acquisiti da Saxa Gres, perché chiusi o sottoposti a procedura di ristrutturazione del debito, da aziende italiane o multinazionali. La più recente acquisizione, avvenuta a inizio 2018, ha avuto ad oggetto un'azienda che, seppur in crisi aziendale per uno squilibrio finanziario ed economico, è nota sul mercato delle piastrelle in ceramica per la capacità di differenziare i propri prodotti rispetto a quelli della concorrenza, grazie a una componente di "artigianalità" difficilmente imitabile. Per questo motivo, e per diversi anni, è stata molto spesso un punto di riferimento del settore, rappresentando un trend setter a cui si ispiravano i competitors. Tale organizzazione ha operato prevalentemente in mercati di sbocco esteri (tutti i mercati europei, Stati Uniti, Canada, paesi dell'ex Unione Sovietica ed estremo oriente), mediante una rete commerciale costituita da agenti prevalentemente plurimandatari, facendo registrare una quota dell'export pari a circa il 75% delle vendite. Attraverso tutte le riconversioni attuate, la Saxa Gres è riuscita a preservare e creare complessivamente circa 500 posti di lavoro altamente qualificati e conseguire i vantaggi derivanti dalle economie di scala dovuti allo sfruttamento delle risorse appartenenti all'intero complesso aziendale. Tutto ciò è finalizzato ad un rapido sviluppo della strategia avviata in modo da creare valore operando in un mercato internazionale che presenta grandi potenzialità di crescita.

Saxa Gres ha recentemente avviato la procedura di registrazione di tre brevetti:

1. brevetto del processo di creazione della miscela ceramica con le ceneri derivanti dai rifiuti degli inceneritori;
2. brevetto del processo di creazione delle piastrelle spesse e di nuove pietre, grazie alla suddetta miscela;
3. marchio Grestone e marchi correlati (Saxa Gres, Saxa Grestone, Woodstone, Greswood, ecc.).

Tale proprietà intellettuale potrà essere utilizzata in differenti modi:

- in licenza per i clienti che possono vendere i prodotti Saxa Gres (Grestone → sanpietrino) con il proprio marchio, integrando la proprietà intellettuale in un terzo modello di "white label";
- nella riconversione delle future fabbriche (ad esempio in Germania, UK, USA, Cina, ecc.) da parte di Saxa Gres con soci di minoranza locali;
- mediante licensing ai produttori esistenti che consentono a Saxa Gres di ricevere royalties.

In ottica di crescita e sviluppo, il management aziendale intende attuare nel medio/lungo termine una dinamica evolutiva della struttura, mediante la costruzione di ulteriori linee per la produzione di pavimentazione urbana negli stabilimenti esistenti e l'acquisizione di fabbriche in altri Paesi europei (soprattutto in Germania, il principale mercato europeo diretto e indiretto, e in Repubblica Ceca) e nel resto del mondo, per ragioni logistiche, commerciali e politiche (potenziali dazi), eventualmente anche in partnerships con investitori locali (specialmente in USA). In pratica, la Saxa Gres è in grado di realizzare "un prodotto innovativo creato dalla combinazione della tecnologia della ceramica, R&D, economia circolare, riconversione industriale, con un focus completo su prodotti e capacità 'Made in Italy'".

4. Analisi di contesto e performance conseguite dalla Saxa Gres SPA

Il mercato globale della pavimentazione è segmentato in quattro categorie: coperture morbide, mercato delle piastrelle, pavimenti in legno e altri, come gomma, vinile e sughero. Nel 2015 tale mercato valeva US$239 miliardi, facendo registrare un incremento del 4,8% rispetto al 2014. Tra il 2015 e il 2020, è prevista una crescita annua del mercato globale della pavimentazione del 6,4% (CAGR), arrivando a valere US$325 miliardi nel 2020. Tale andamento positivo è riconducibile al previsto incremento dell'industria immobiliare ed edile in tutto il mondo, supportata dall'incremento dei consumi nei paesi industrializzati, come negli Stati Uniti, e da favorevoli condizioni di vendite in diversi paesi in via di sviluppo. Inoltre, la crescente domanda nell'industria della pavimentazione sarà generata dalla crescente industrializzazione e dall'aumento reddito pro-capite e del tenore di vita nelle economie emergenti. Tuttavia, la crescita dell'industria della

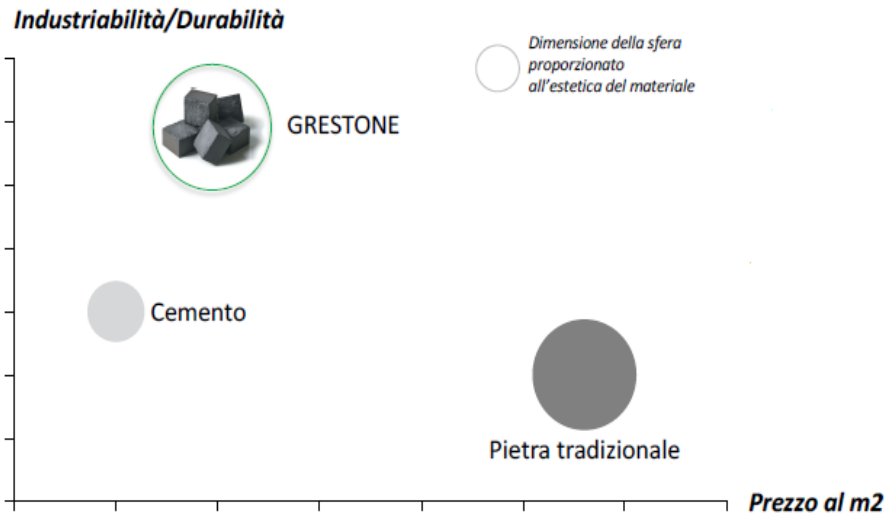
ceramica nella categoria della pavimentazione non resiliente potrebbe essere soggetta a nuove sfide in conseguenza dell'eventuale introduzione di ulteriori normative ambientali. In un tale scenario, Saxa Gres potrebbe sfruttare il proprio potenziale grazie al Green Public Procurement (GPP) e al "sanpietrino" Grestone per la pavimentazione degli ambienti esterni. Il mercato della pavimentazione per esterni ha subito negli ultimi anni una crescita notevole spinta dal più generale incremento dei consumi per arredi e design. Nel 2016 il mercato globale della pavimentazione per esterni ha contribuito per il 33,7% al mercato globale della pavimentazione e ci si attende una crescita del mercato fino a US$109,8 miliardi nel 2021. Si prevede, inoltre, che la regione APAC continui a dominare il mercato con il 58,9% nel 2021, seguita da EMEA (21,4%) e dalle Americhe (19,7%). In particolare, la crescita del mercato globale della pavimentazione da esterni sarà trainata dall'aumento del potere d'acquisto del consumatore che sosterrà la domanda per l'innovazione del prodotto, dove il design e l'estetica svolgono un ruolo chiave. Oltre al settore residenziale, le pavimentazioni pubbliche per comuni e complessi sportivi commerciali rappresentano i principali driver della domanda per mercati di pavimentazioni da esterni. Si ritiene importante evidenziare che il settore della ceramica e, più in generale, delle piastrelle e pavimentazioni sta vivendo un periodo di particolare dinamismo sia per le operazioni di mergers & acquisitions sia per l'ammontare degli investimenti operativi. Le motivazioni principali di tale trend sono da ricercare:

- nelle spinte aggregative in poli concentrati per far fronte alla pressione competitiva dei player asiatici;
- investimenti in nuove tecnologie per migliorare la qualità dei prodotti e per soddisfare la crescente esigenza di operare in ottica di sostenibilità.

Come già detto, l'intuizione originale di Saxa Gres nell'applicare i principi dell'economia circolare, nell'ambito del progetto Grestone, è che le ceneri derivanti dagli scarti dei moderni inceneritori possono essere utilizzate fino al 30% - per motivi di fattibilità tecnica - nella composizione di piastrelle di gres porcellanato di alta qualità. Ceneri che prima di essere introdotte nel processo produttivo sono trattate dall'Azienda in modo da renderle totalmente inertizzate per tutelare la salute dei consumatori. Durante tale fase, le ceneri vengono demetalizzate e deferrizzate anche al fine di recuperare e riciclare i metalli presenti che altrimenti sarebbero destinati a discarica.

Il risultato è un prodotto con caratteristiche del tutto similari a quelli creati con composizioni tradizionali. Il successo iniziale delle piastrelle con spessore di vari formati, proveniente dalla domanda di gamma alta da parte di consumatori del Nord Europa per esterni e giardini (per la facilità di installazione rispetto alle tradizionali piastrelle più sottili), ha portato a sperimentare piastrelle ancora più spesse e a sviluppare il Grestone. La combinazione unica di tecniche usate da Saxa Gres, proveniente dalle piastrelle, prodotti sanitari e dalla fabbricazione del mattone, traendo pieno vantaggio dal digital printing, garantisce una pietra più economica e di alta qualità, con precisione nelle misure, resistenza, ruvidezza, ecc. Analizzando il Grestone rispetto ai prodotti sostitutivi emergono notevoli differenze in termini di performance superiore e prezzo di vendita nettamente inferiore. Esso presenta una vita media superiore di circa 3/4 volte rispetto al cemento e non è soggetto al processo di assorbimento di acqua, fluidi e smog. Rispetto alla pietra tradizionale, il Grestone è caratterizzato da un costo al metro quadro marcatamente inferiore, pur preservando la stessa estetica e migliori performance tecniche in termini di durezza, resistenza, impermeabilità, omogeneità nel tempo e facilità di installazione. Tutti i prodotti della linea Grestone sono certificati ed essendo realizzati con un materiale riproducibile, non presentano, al contrario della pietra, problemi di approvvigionamento.

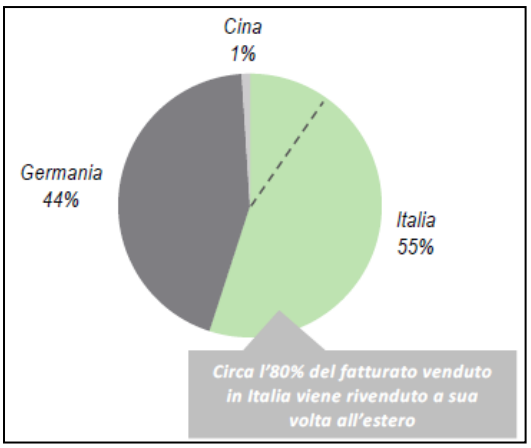
Fig. 2: Confronto tra il Grestone e i materiali tradizionali sulla base dell'industriabilità/scalabilità del prodotto, prezzo al metro quadro e parametro estetico



Fonte: Saxa Gres SPA, 2019

Per quanto riguarda l'andamento delle vendite della Saxa Gres, nel 2016 il fatturato è stato di € 101.045 mentre nel 2017 ammontava a € 10.742.510 di cui 1.751.764 derivanti dal mercato estero. Al 31/12/2018 è stato registrato un incremento sostanziale dei ricavi che sono stati pari a € 23.557.000, sostenuti dalla vendita dei prodotti della linea Grestone, ripartiti tra Italia (55%), Germania (44%) e Cina (1%). Comunque, è stato riscontrato che circa l'80% dei prodotti venduti nel contesto nazionale, in questi ultimi sette mesi analizzati, sono stati successivamente destinati al mercato estero.

Fig. 3: Ricavi per area geografica



Fonte: Saxa Gres SPA, 2019

I costi per l'approvvigionamento delle materie prime sono stati quantificati in € 1.088.496 nel 2016, € 3.046.725 nel 2017 ed € 9.069.000 nel 2018. L'EBITDA è stato determinato in € 80.000 nel 2017 ed € 3.800.000 nel 2018, mentre l'EBIT è passato dai valori negativi del 2017 (-1.928.000 euro) ai valori positivi rilevati al termine del 2018 (€ 1.303.000).

Per il 2019 la Saxa Gres ha stipulato contratti, ricevuto ordini e manifestazioni di interesse per oltre il 90% del fatturato del 2018 da parte di clienti storici o di standing primari.

Sulla base delle informazioni acquisite e dei documenti disponibili, è stata effettuata un'analisi SWOT i cui risultati sono riportati nella tabella che segue.

Tab. 2: Analisi Swot

Ambiente interno	**Punti di forza** • Materiali più performanti derivanti dall'incenerazione dei rifiuti con un impatto positivo sull'ambiente • Vantaggio del *first mover* nell'utilizzo delle ceneri nell'Economia Circolare per la pavimentazione urbana • Integrazione con nuove tecnologie (ad esempio, stampa digitale) per prodotti totalmente innovativi • Minori costi di acquisizione delle materie prime anche per la disponibilità di una cava di proprietà • Tre impianti con profonda specializzazione su prodotti differenti	**Punti di debolezza** • Riconversioni industriali che potrebbero richiedere più tempo del previsto • Alto livello di burocrazia nella politica locale e nazionale: processo di autorizzazione lento a causa della presenza di differenti livelli di istituzioni politiche (Stato, Regioni, Province, Comuni ecc.)
Ambiente esterno	**Opportunità** • Enormi potenzialità del mercato domestico e opportunità di entrare in nuovi mercati internazionali • Interazioni potenziali con *top brands* • Il *Green Public Procurement* fornirà un vantaggio significativo nelle gare d'appalto pubbliche grazie ai prodotti ottenuti dal riciclo dei rifiuti • Benefici finanziari derivanti dai fondi pubblici (per esempio Industria 4.0)	**Minacce** • Influenza del mercato delle costruzioni, ancora in fase di ripresa dalla crisi finanziaria • Prodotti sostitutivi dei competitors • Il rischio derivante da un portafoglio composto da pochi, seppur rilevanti, clienti • Rischi connessi al processo di risanamento di entità acquisite e al rilancio del relativo marchio

Fonte: elaborazione propria su dati Saxa Gres

Dall'analisi globalmente effettuata emergono chiaramente alcune considerazioni. In primis, la capacità di attrazione di risorse finanziarie provenienti da enti pubblici italiani e investitori nazionali e internazionali da parte di un business innovativo, fondato sui principi dell'economia circolare, seppur operante in un contesto duramente colpito dalla crisi economico finanziria degli ultimi anni. Tali risorse hanno consentito, infatti, la "riapertura dei cancelli" di siti produttivi storici e il recupero di risorse umane dotate di un elevato background artigianale, in termini di competenze e abilità, essenziale per avviare un processo produttivo del tutto innovativo. Attraverso una efficace attività di ricerca, sviluppo e innovazione, infatti, la Saxa Gres SPA ha sviluppato tre brevetti riguardanti il prodotto, il processo produttivo e il rivoluzionario "impasto". In tal modo l'Azienda può attuare una strategia di crescita mediante la diversificazione e l'espansione su grandi mercati europei che presentano un elevato livello di attrattività. Inoltre, i risultati conseguiti da Saxa Gres valorizzano oggettivamente da una parte una best practice nazionale che può contribuire al rilancio del settore manifatturiero, dall'altra evidenziano come lo scarto derivante dal trattamento dei rifuiti urbani può assumere il ruolo di risorsa critica per la sopravvivenza di un'azienda e la creazione di valore condiviso con gli stakeholder anche in termini di salvaguardia dell'ambiente.

5. Considerazioni conclusive e implicazioni manageriali

Dall'analisi della letteratura sull'economia circolare e dalle considerazioni emerse in merito al caso di studio esaminato risulta chiaramente che la transizione dal modello economico lineare a quello circolare rappresenta un cambiamento dirompente e più complesso delle rivoluzioni della sostenibilità oltre che uno dei modelli di business più complicati da implementare. Questo perché la circolarità implica, per l'impresa orientata in tal senso, una dotazione di risorse, conoscenze e abilità tali da rendere possibile l'innovazione circolare. I cambiamenti riguardano in primis l'intero sistema di dotazione e gestione delle risorse umane, i processi di approvvigionamento, di

produzione e di consumo, la progettazione di nuove tecnologie e di nuovi prodotti, la strutturazione dell'organizzazione interna e la rimodulazione dei rapporti esterni (Carpenter *et al.*, 2018). L'economia circolare, pur basandosi su sei principi convenzionali (6R), ingloba un assunto generale che è trasversale a tutti i processi: considerare l'economia e l'ambiente come due sistemi che si influenzano e condizionano reciprocamente. Partendo da questa constatazione, si può delineare un rapporto di interdipendenza tra economia e ambiente. L'ambiente, infatti, è dapprima fonte di approvvigionamento di materie da introdurre nel processo produttivo e poi diventa soggetto passivo nel momento della dismissione dei rifiuti e dei beni obsoleti. L'obiettivo principale dell'economia circolare è quello di emulare i processi che avvengono all'interno del ciclo naturale per armonizzare il modello economico con le necessità ambientali. L'idea di fondo implica la cooperazione e il coordinamento tra l'impresa e tutti gli agenti economici e sociali, come nel caso di alcune specie animali che rigenerano gli scarti del mondo naturale mantenendo l'ecosistema in equilibrio (Sauvé *et al.*, 2016). L'economia circolare, pertanto, può essere considerata come la risposta al processo di ricerca del modello economico adatto per l'implementazione corretta di uno sviluppo sostenibile. Inoltre, non si può trascurare il ruolo dell'economia circolare nel determinare la fine dell'obsolescenza programmata (Bulow, 1986; Waldman, 2003; Guiltinan, 2009; Cooper, 2010; Agrawal *et al.*, 2015) per gli sforzi che vengono attuati al fine di allungare la durata della vita utile dei prodotti accrescendone la qualità e riducendo i tassi di sostituzione. Dall'analisi del caso di studio emerge chiaramente che anche le piccole e medie imprese (PMI) possono trarre notevoli vantaggi da un modello innovativo che può essere definito "open circular economy" proprio perché alla tipica filiera circolare di tipo chiuso associa input derivanti dall'ambiente esterno, che esulano da quelli derivanti dai processi industriali e/o commerciali. A tutto ciò bisogna associare il miglioramento dell'efficienza delle risorse mediante la concreta riduzione dei costi variabili e il risparmio sul costo complessivo delle materie prime, il conseguimento di vantaggi competitivi anche per effetto della reputazione acquisita, la possibilità di operare su nuovi mercati e quindi la resilienza a lungo termine. Tutto ciò rispecchia quanto riscontrato nella letteratura recente, in cui si evidenzia come per le imprese che presentano una forte propensione all'innovazione sia più facile adottare pratiche circolari (Jakhar *et al.*, 2018). A livello manageriale, l'analisi SWOT effettuata in relazione al caso di studio offre una base informativa per formulare politiche e strategie, sia per promuovere la transizione delle imprese verso modelli circolari sia per affrontare le sfide che possono ostacolarne l'implementazione. Il successo commerciale di Saxa Gres, seppur conseguito in pochi anni di attività, può rappresentare un incentivo per i competitor, diretti e indiretti, a implementare modelli di business simili (Winans *et al.*, 2017) anche per la crescente consapevolezza da parte dei consumatori dell'importanza dei prodotti realizzati attraverso un processo circolare. Inoltre, l'utilizzo di materie prime a costo zero, quali l'argilla proveniente dalla cava di proprietà e l'utilizzo di ceneri derivanti da termovalorizzatori nel processo produttivo, consentono di rilevare oggettivamente un notevole risparmio di costi con effetti positivi sui margini e quindi sui risultati economici aziendali oltre a una maggiore efficienza nell'impiego delle risorse finanziarie. Tuttavia, si ritiene rilevante evidenziare che le ceneri derivanti da termovalorizzatori che trattano rifiuti urbani in tal modo diventano risorse critiche per il successo economico e reputazionale delle imprese che le utilizzano, con conseguenze positive anche per la collettività per due ordini di motivi:

- perchè altrimenti ricadono proprio sulla collettività (direttamente e indirettamente) i notevoli costi per il loro smaltimento e per la gestione delle discariche (Korhonen *et al.*, 2018);
- per gli effetti positivi che si determinano a livello di salvaguardia ambientale.

Inoltre, il caso di studio trattato è emblematico perché si tratta di un'azienda che, pur essendo partecipata anche da importanti fondi internazionali, ha implementato una strategia basata sull'economia circolare creando valore in un'area già gravemente danneggiata dalle numerose e frequenti chiusure e/o dismissioni di importanti stabilimenti industriali, garantendo una coesione economica e sociale fortemente a rischio nell'area di interesse. Rivitalizzando infrastrutture esistenti, minimizzando gli investimenti e riassorbendo una forza lavoro (Korhonen *et al.*, 2018) dotata di *know-how e* competenze manifatturiere distintive sedimentatesi in diversi anni di attività,

Saxa Gres è riuscita a generare benefici in termini economici, di costi sociali e di tutela ambientale affermando il principio della circolarità in tutte le sue attività. Circolare è il percorso che ha portato alla riapertura di impianti storici in zone colpite dalla crisi e circolari sono le modalità di produzione dei materiali, realizzati con un mix di ceneri e argille provenienti da cave e inceneritori locali, che garantiscono la certificazione Ecolabel a prodotti dotati del massimo livello di componente Green. Si tratta di scelte "a km 0", che ridanno nuova vita e dignità a materiali di scarto, con effetti molto positivi in termini di sostenibilità economica e ambientale, oltre che a interi territori che hanno tutte le potenzialità per poter tornare a pensare in grande. Condividendo quanto affermato dalla Ellen MacArthur Foundation "il passaggio a un'economia circolare non significa solo aggiustamenti volti a ridurre gli impatti negativi dell'economia lineare. Piuttosto, rappresenta un cambiamento sistemico che costruisce la resilienza a lungo termine, genera opportunità commerciali ed economiche e fornisce benefici ambientali e sociali".

6. Limiti e sviluppi futuri

Il presente lavoro di ricerca, pur fornendo evidenze interessanti derivanti dall'analisi incentrata su un'azienda di successo, presenta il limite del singolo caso di studio che non permette la generalizzazione dei risultati ottenuti. Inoltre, risente del ridotto orizzonte temporale analizzato dovuto alla recente costituzione dell'organizzazione presa in esame. Pertanto, per la ricerca futura si prevede sia di indagare sui livelli di competitività conseguiti dalla Saxa Gres sul mercato nazionale e internazionale anche attraverso analisi quantitative, sia di confrontare i risultati ottenuti con lo studio di casi multipli riguardanti PMI italiane localizzate anche in aree geografiche diverse.

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Consumers' attitude and purchase intention towards organic personal care products. An application of the S-O-R model♦

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Abstract

Objectives. *Guided by the Stimulus-Organism-Response (S-O-R) model, the study investigated whether and how six environmental stimuli related to the consumers' experience with organic personal care products influenced their attitudinal responses (hedonic and utilitarian) which, in turn, affected buying behaviour.*

Methodology. *The empirical research builds on an online survey with a sample of 161 consumers. A structural equation model was performed to analyse the data.*

Findings. *Results showed that knowledge about organic PCP and sensory appeal significantly improved the utilitarian and hedonic attitude towards these products. Contextually, natural content attributes and quality perception positively influence utilitarian attitude. Finally, both the affective and functional attitudinal dimensions significantly increased the purchase intention.*

Research limits. *Further research is recommended in order to measure actual purchase behaviour and to extend the investigation to a larger sample that is representative of the general population. Moreover, longitudinal studies are required to examine whether changes in consumer attitude, perception and buying with regard to organic PCP happen in time.*

Practical implications. *Highlighting the determinants of consumers' attitude and purchase intention, the paper provides valuable insight to manufacturers and retailers for the increasing in organic PCP market share.*

Originality of the study. *The study showed that the S-O-R model is an adequate theoretical framework to investigate the decision-making process in the context of organic PCP. Furthermore, the proposed theoretical model sheds light on the role of new relevant variables which affect the consumers' evaluation towards these products and that have been neglected in past research.*

Key words: *organic cosmetic product; utilitarian attitude; hedonic attitude; purchase intention; Stimulus-Organism-Response model; structural equation modelling*

♦ Authors' contributions: Beatrice Luceri wrote the Introduction and Limitation. Donata Tania Vergura is responsible for the Theoretical Framework, Results and Discussion and Conclusion. Cristina Zerbini contributed to Hypotheses development and Method.

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1. Introduction

In recent years, the rising consumer interest in health issues has fuelled the attention for healthier habits and lifestyles that benefit the physical, mental and emotional well-being. In particular, the awareness of the hazards of synthetic chemicals has increased the demand for organic personal care products (Ghazali *et al.*, 2017). Different studies, in fact, indicate that using types of toxic and dangerous chemicals in cosmetics production is closely related to cancers, proliferation deficiencies, abortion and respiratory and skin sensitivities (e.g., Borowska and Brzóska, 2015; Darbre, 2001; Darbre, 2003; Harvey and Darbre, 2004; Kaličanin and Velimirović, 2016; Mellowship, 2009; Si and Praveena, 2015). As a consequence, the market for natural and organic cosmetics is expanding globally and it is projected to reach USD 25 billion by 2025 (Grand View Research Inc., 2016).

Organic personal care products (PCP) comprise skin care, hair care, oral care, colour cosmetics, deodorants, toiletries and hygiene products which originate from organic farming without direct contact with synthetic fertilizers and pesticides. Moreover, in the production it is not possible to use derivatives from petroleum (paraffin, formaldehyde and colorants of synthetic origin) sewage sludge, genetically modified organisms or ionizing radiation (CCPB.it, 2019; Organic.org, 2019). Those ingredients are substituted by vegetal derivatives, safer for human health and with more attention to the safeguard of the environment. This makes the organic PCP desirable among both health conscious and environmental conscious consumers.

As a consequence of both public debate and consumer demand for organic PCP many cosmetic companies are gradually switching to organic ingredients and ecological standards. Similarly, some retailers have started to remove non-organic cosmetics/hygiene products from their shelves (Hansen *et al.*, 2012). To address this challenge, understanding the consumer decision-making process is paramount as it allows to determine the variables that influence the interest in organic PCP and the willingness to buy them.

Consumers' attitude and behaviour towards organic foods have been deeply explored in literature (e.g., Al-Swidi *et al.*, 2014; Cabuk *et al.*, 2014; Chen, 2007; de Magistris and Gracia, 2008; Lee and Goudeau, 2014; Lee and Yun, 2015; Paul and Rana, 2012; Teng and Wang, 2015). On the contrary, although the personal care market is one of the most growing consumer markets, only few research studies emerges that investigated the consumer behaviour towards organic PCP (Ghazali *et al.*, 2017; Hansen *et al.*, 2012; Matić and Puh, 2015; Mombeini *et al.*, 2015; Yeon and Chung, 2011). Among these, most focused on the effect of personal values (like health consciousness, environmental consciousness and social consciousness) on behavioural intention, neglecting to consider other relevant variables that could affect the decision-making process.

That being stated, the present study provides a more grounded exploration of consumer attitude and purchase intention towards organic PCP, using recent theoretical advances related to the Stimulus-Organism-Response (S-O-R) framework (Mehrabian and Russell, 1974). The first objective is to investigate the relationships between the environmental stimuli related to the consumers' experience with organic PCP (i.e., knowledge, natural content, ecological welfare, sensory appeal, quality and price) and the utilitarian and hedonic attitudes towards these products. The second aim is to examine whether and how such cognitive and affective responses influence buying intention.

As a result, the paper contributes both theoretically and empirically to the understanding of organic PCP. At the theoretical level, it demonstrates that the S-O-R model is an adequate theoretical framework to investigate the decision-making process in the context of organic PCP. At the empirical level, the understanding of the determinants of consumers' purchase intention is valuable to manufacturers and retailers for the increasing in organic PCP market share.

2. Theoretical Framework

The conceptual foundations of the proposed model and related hypotheses are drawn from the Stimulus-Organism-Response (S-O-R) model. The S-O-R framework was first developed by Mehrabian and Russell (1974) in the context of environmental psychology and later extended in other contexts, including the retail setting and many other areas of consumer behaviour to explain the consumer decision making process (e.g., Baker *et al.*, 1992; Chang *et al.*, 2011; Chebat and Michon, 2003; Eroglu *et al.*, 2001; 2003; Islam and Rahman, 2017; Kang and Sohaib, 2015; Kim and Lennon, 2013; Mollen and Wilson, 2010; Rose *et al.*, 2012). The paradigm postulates that Stimuli from the environment influence an individual's cognitive and affective reactions (Organism), which in turn lead to some behavioural Responses (Donovan and Rositer, 1982). More specifically, the stimuli are defined as those factors that arouse the individual affecting his/her internal sates. With reference to consumers' behaviour, Bagozzi (1986) conceptualized stimuli as both marketing mix variables and other environmental inputs that affect the emotional responses of the consumer (e.g., atmosphere, visual appeal, accessibility, social cues, customer service, information). The organism element of the S-O-R framework is the internal state of the individual that intercedes between the stimuli and behavioural responses. In the Mehrabian and Russell's initial S-O-R model, organism was represented by three emotional states: pleasure, arousal, and dominance (PAD). Subsequently, the PAD approach was criticized and several authors conceptualized organism as a cognitive and affective internal state (e.g., Bitner, 1992; Eroglu *et al.*, 2001; Holbrook and Hirschman, 1982; Lee *et al.*, 2011). Affective state reflects the arousal and pleasure displayed in response to the environmental stimuli. Cognitive state comprises individuals' mental processes concerning the acquisition, processing, retention, and retrieval of information (Eroglu *et al.*, 2001). These two psychological constructs have been consistently identified as influential components of customer behaviour and experience (e.g., Bagozzi *et al.*, 1999; Frow and Payne 2007; Tynan and McKechnie, 2009) and have often been operationalized through attitudinal measures (e.g., Eroglu *et al.*, 2001; Fiore, 2002; Fiore and Kim, 2007; Lee and Yun, 2015). The final outcome in the S-O-R paradigm is the behavioural response affected by the internal state, which can be classified as either approach or avoidance (Mehrabian and Russell, 1974). Approach behaviours include all positive actions that might be directed towards a particular setting (e.g., positive communications, intention to purchase/to act, etc.), whereas avoidance behaviours reflect the opposite responses such as negative communications and no intention to purchase.

According to the S-O-R framework, the theoretical model in the present study views consumer engagement with organic PCP as consisting of three components (see Figure 1). The first comprises the individual's knowledge about and experience with these products, which act as external stimuli that affect the experiential response. The second component is represented by the internal state that arouses the individual, expressed as attitude towards organic PCP. Most prior research on organic PCP, starting from the Theory of Planned Behaviour (Ajzen's, 1991), has been concentrated on attitude as a single evaluative dimension (Ghazali *et al.*, 2017; Hansen *et al.*, 2012; Kim and Chung, 2011; Mombeini *et al.*, 2015). Following the approach adopted by Lee and Yun (2015) in the context of organic foods, this study employed a bi-dimensional conceptualization of attitude. Attitude towards behaviour refers to the degree to which a person has a favourable or unfavourable evaluation or appraisal of that behaviour (Ajzen and Fishbein, 2005). Literature on consumption behaviours highlighted that there exist two dimensions of consumer evaluation: (a) an utilitarian dimension (instrumental or functional) which concerns with how useful or beneficial an object is; and (b) an hedonic (affective gratification) dimension measuring the experiential affect associated with the object (e.g., how pleasant and agreeable the feelings to the product are) (Batra and Ahtola, 1990; Holbrook and Hirschman, 1982; Millar and Tesser, 1986; Triandis, 1977). In the context of organic food purchases, for example, utilitarian attitude reflects consumers' assessment of how useful or beneficial buying organic food is, while hedonic attitude refers to whether buying organic food is pleasant or delightful (Lee and Yun, 2015). Sharing with this view, both utilitarian and hedonic attitudes towards organic PCP were measured to adequately represent cognitive and

affective internal states. Finally, the third component of the model is the behavioural response of consumers, which is represented by the intention to purchase organic PCP.

3. Hypotheses development

Five antecedent variables are proposed as external stimuli which can influence the cognitive and affective state towards organic personal care products. The selection was made according to the relevant literature and to their expected relevance in the context under investigation.

The first set of variables is related to the consciousness about organic PCP, measured in terms of product knowledge (i.e., information, familiarity and purchasing experience), awareness of their natural content and awareness of the ecological benefits. Product knowledge is an important factor in the consumer decision-making process (Alba and Hutchinson, 1987; Brucks, 1985). In literature two conceptually different constructs are distinguished: objective knowledge, i.e. the accurate information stored in the consumer's long-term memory; and subjective knowledge, i.e. the consumer's self-perception of how much he knows about a product or service (Brucks, 1985; Park *et al.*, 1994; Selnes and Gronhaug, 1986). Among the two dimensions, subjective knowledge was found to be a stronger determinant of attitude and behaviour than objective knowledge (e.g., Feick *et al.*, 1992; Pieniak *et al.*, 2006). Several authors highlight the importance of this construct in the analysis of pro-environmental behaviour and purchase of organic food (Aertsens *et al.*, 2011; Chryssochoidis, 2000; Ellen, 1994; de Magistris and Gracia, 2008; Padel and Foster, 2005; Stobbelaar *et al.*, 2007; Teng and Wang, 2015; Thøgersen *et al.*, 2010). On the contrary, in the context of organic PCP only one study emerges which explored the impact of subjective knowledge on the attitude towards re-purchasing founding a positive relationship (Ghazali *et al.*, 2017). The present study intends to enrich the literature investigating the dual relationship between subjective knowledge of organic PCP and the two dimension of attitude. It is expected that better product knowledge would lead to more positive hedonic and utilitarian attitudes towards organic PCP. Hence, the following hypothesis is formulated:

H1: Knowledge about organic PCP significantly increases (a) utilitarian attitude and (b) hedonic attitude towards these products.

Natural content and ecological welfare attributes pertain to the safety and environmental benefits associated to organic PCP production and use. Kim and Chung (2011) and Mombeini *et al.* (2015) showed that consumer values (including health consciousness and environmental consciousness) significantly increase attitude towards buying organic skin/hair care products. However, they measured values in general way (i.e., "attention to health" and "attention to environment") and not with specific reference to organic products. To the authors' knowledge, only Ghazali *et al.* (2017) measured environmental and safety values associated to organic PCP, demonstrating their positive effect on attitude towards re-purchasing. In a similar vein, Lee and Yun (2015) explored the impact of natural content and ecological welfare attributes of organic food on consumers' utilitarian and hedonic attitude, but did not found the natural content effect significant. This study aims to shed light on such relationships in the context of organic PCP and hypothesises that the awareness of natural content and ecological welfare attributes could positively influence the utilitarian dimension of the consumer's evaluation process. On the contrary, since hedonic motivation is associated with fun and playfulness rather than functionality (Holbrook and Hirschman, 1982), the affective gratification (excitement, arousal, delight) deriving from the use of organic product is not supposed to be influenced by functional attributes like natural content and ecological welfare. In light of this reasoning, the following hypotheses are stated:

H2: Consumers' perception of (a) natural content and (b) ecological welfare attributes of organic PCP significantly increases utilitarian attitude towards these products.

H3: Consumers' perception of (a) natural content and (b) ecological welfare attributes of organic PCP does not significantly impact on hedonic attitude towards these products.

The second set of variables concerns the product evaluation, measured as sensory appeal, perceived quality and price. Except for Rybowska (2014), which found that the most important reason for not buying eco cosmetics was too high price, there is a lack of literature exploring potential links between such variables and attitude/behaviour towards organic PCP. Sensory aspects have been proven to be an important factor in organic food choice (e.g., Chen, 2007; Lee and Yun, 2015). Particularly, Lee and Yun (2015) found a positive impact of sensory appeal on hedonic attitude. Similar to food, sensory stimuli are relevant in the cosmetics/hygiene products evaluation and influence the associated emotions, perceived quality and satisfaction (Theofanides and Kerasidou, 2012). Therefore, in the fourth hypothesis it is supposed that sensory appeal of organic PCP could increase the utilitarian and hedonic benefits associated to such products.

H4: Sensory appeal of organic PCP significantly increases (a) utilitarian attitude and (b) hedonic attitude towards these products.

The marketing literature suggests that the quality expectation of the various product alternatives is an important factor in consumer choice behaviour (Narasimhan and Sen, 1992; Steenkamp, 1989; Steenkamp and Van Trijp, 1996). In the context of organic food products, Gracia and De Magistris (2008) highlighted that the importance consumers attach to the organic food quality positively influence the level of consumption. In a similar way, if consumers perceived that organic personal care products have higher quality than conventional, their attitude towards such product should improve. Therefore, the following hypothesis is formulated:

H5: Perceived quality of organic PCP significantly increases (a) utilitarian attitude and (b) hedonic attitude towards these products.

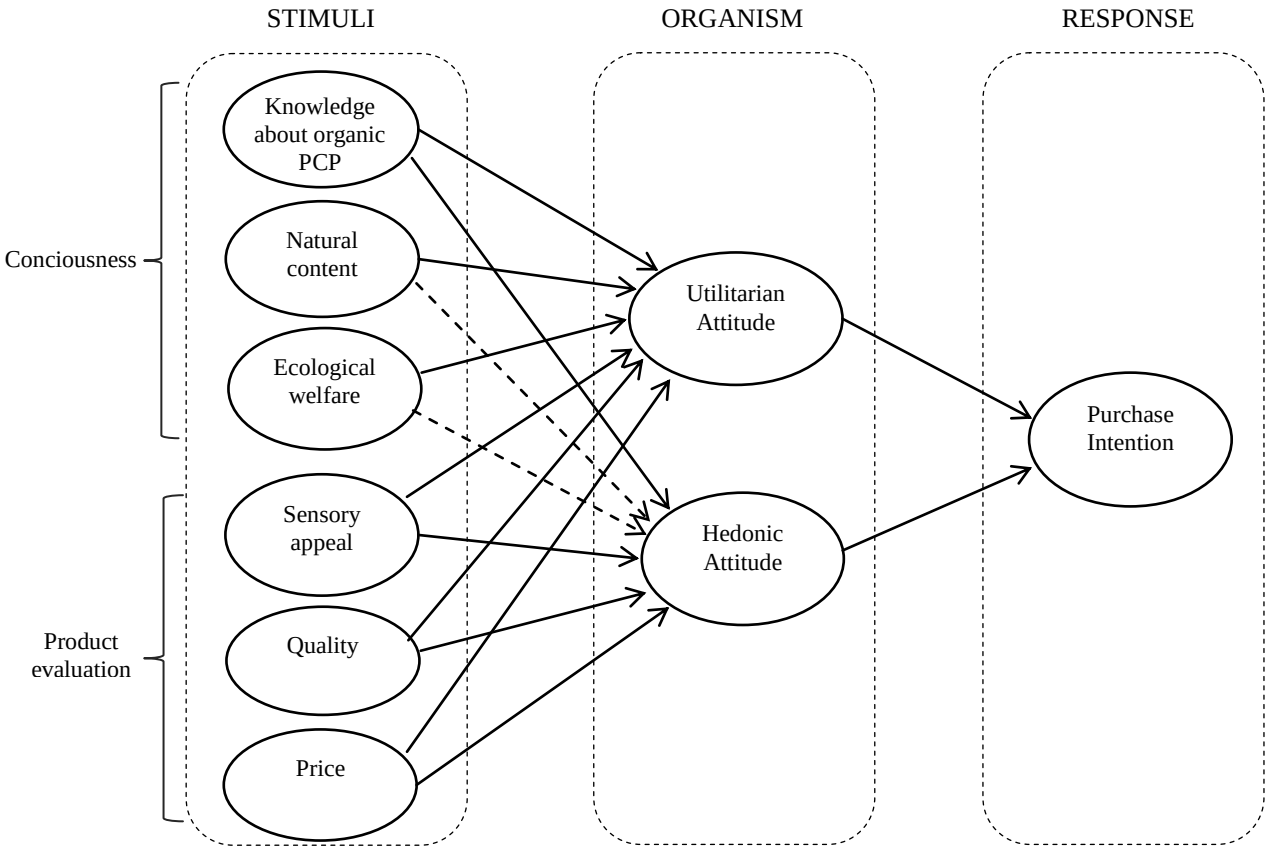
Except for the aforementioned study of Rybowska (2014) and that of Cervellon *et al.* (2011), which explored the consumers' willingness to pay for organic shampoo, to the authors' knowledge no studies exist that investigate the impact of perceived price on attitude or purchase intention. Shifting the focus on the organic food sector, the vein of research analysing such relationship has provided contradictory results. If Lee and Yun (2015) suggested that perceived expensiveness decreases the hedonic and the utilitarian attitude, Chen (2017) did not found a significant relationship. Sharing with the Lee and Yun (2015) findings, this study intends to investigate if the price evaluation contributes to the perception of hedonic and utilitarian benefits associated with organic PCP. More specifically, it is supposed that:

H6: Perceived expensiveness of organic PCP significantly decreases (a) utilitarian attitude and (b) hedonic attitude towards these products.

The last hypothesis concerns the relationship between the attitudinal reactions to the stimuli and the behavioural response (purchase intention) conceptualized in the S-O-R model. Following the TPB (Ajzen's, 1991) basic assumptions, several authors highlighted the positive influence of attitude towards (purchasing) organic PCP on purchase intention. The present study aims to enrich such findings investigating the separate effect of utilitarian attitude and hedonic attitude on intention to buy.

H7: (a) Utilitarian attitude and (b) hedonic attitude towards organic PCP have a significant positive effect on intention to purchase these products.

Fig. 1: Conceptual model



---- Relationships hypothesised not significant

Source: our elaboration

4. Method

A self-administered questionnaire was sent in electronic form to a sample of Italian people between September and October 2018. Respondents immediately read the definition of organic PCP. Then, only those who have purchased such products at least once were able to proceed with the interview. The final sample size was equal to 161 valid questionnaires (72% female and 28% males; mean age = 31.8 ranging from 18 to 61).

The latent variables were measured using scales that have been well validated in the literature. Knowledge about organic PCP was measured through the five items developed by Park *et al.* (1992). The three-items scales proposed by Steptoe *et al.* (1995) were used to measure natural content and sensory appeal. Ecological welfare was assessed by the Lindeman and Vaananen (2000) four-items scale. Product quality was measured with one item developed by Gracia and De Magistris in the context of organic food (2007). Two items (Yoo *et al.*, 2000) collected the perceived expensiveness of organic PCP. Utilitarian attitude and hedonic attitude were assessed through three and five items respectively. The two scales, measured on a seven-point semantic differential, were developed by Voss *et al.* (2003). Finally, purchase intention was assessed using the three-items scale of Teng and Wang (2015). All statements, except for the two attitude scales, were on a seven-point anchored scale (from “completely disagree” to “completely agree”). The items used in the questionnaire are shown in Appendix A.

4.1 Analytical procedure

Data underwent two phases of analysis. First, Cronbach's alpha and confirmatory factor analysis (CFA) were used to examine the construct validity and reliability of the scales. Second, the paths of relationships between the latent variables were explored. Structural equation modelling (SEM) with maximum likelihood method was employed for the analysis of the measurement model (CFA) and of the conceptual model.

The fit of the models was interpreted based on a range of fit indices, namely the Chi-square (χ^2) value, the degree of freedom (df), the comparative fit index (CFI), the non-normed fit index (NNFI), the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR). Data analysis was performed using the IBM SPSS statistical software (SPSS Inc, Chicago, IL; release 25.0) and the LISREL software (release 8.80).

5. Results

5.1 Preliminary data analysis

The internal consistency reliability (Cronbach's alpha) was very high for each construct, ranging from 0.72 to 0.93. All items had a high item-total correlation, and the alpha value did not increase when each item was removed. The analysis of the measurement model showed an acceptable overall fit. As the skew and kurtosis statistics showed that the normality assumption was violated, the models were estimated using the Satorra-Bentler method (Satorra and Bentler, 1994): $\chi^2 = 519.50$, df = 342, $p = 0.000$, CFI = 0.98, RMSEA = 0.06, NNFI = 0.97, SRMR = 0.09.

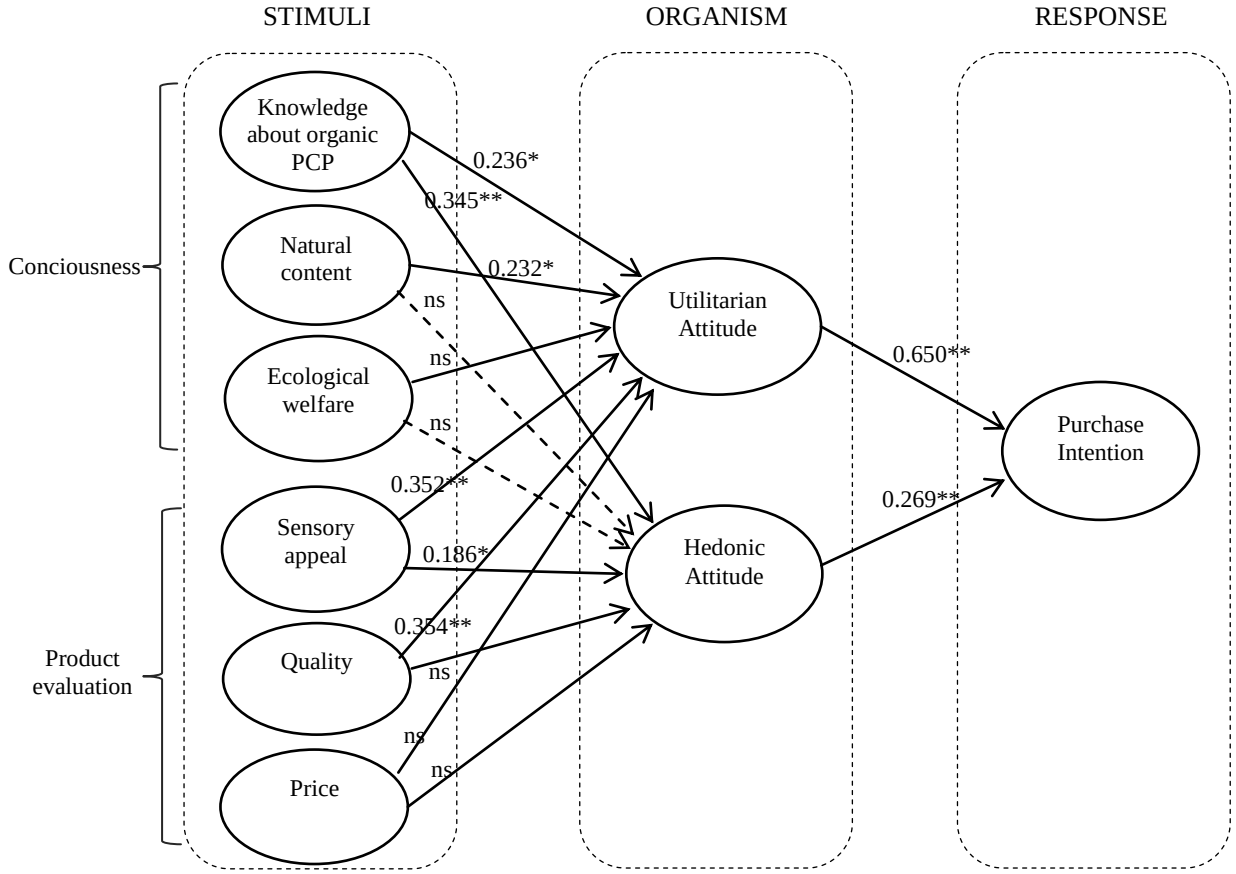
All items loaded strongly and significantly on the hypothesised latent variables and all constructs exceeded the recommended cut-off points for the adequacy of 0.70 for the Composite Reliability (CR; Steenkamp and Van Trijp, 1991) and 0.50 for the Average Variance Extracted (AVE; Fornell and Larcker, 1981). Finally, the data met the Fornell and Larcker's (1981) criterion: the average variance explained by each latent variable was greater than any of the squared correlations involving the variable, suggesting that discriminant validity was achieved.

5.2 Test of structural model

Results revealed that the structural model fits the data well ($\chi^2 = 117.29$, df = 279, $p = 0.000$, CFI = 0.98, RMSEA = 0.06, NNFI = 0.98, SRMR = 0.09) (Figure 1). Overall, the model explains 67% of the variance for purchase intention. The significant parameters estimates are shown in Figure 2.

The examination of the path coefficients and t-values indicated that knowledge about organic PCP significantly influenced utilitarian ($\beta = 0.236$, $p < 0.05$) and hedonic attitude ($\beta = 0.345$, $p < 0.01$) towards these products, thus completely supporting H1. On the contrary, H2 was only partially supported by empirical data. Among the two other variables measuring the consciousness about organic PCP, only natural content exerted a significant and positive impact on utilitarian attitude ($\beta = 0.232$, $p < 0.05$), while the effect of ecological welfare was found not significant. As expected, perception of (a) natural content and (b) ecological welfare attributes of organic PCP did not significantly impact on hedonic attitude towards these products. Therefore, H3 was supported. According to H4, the higher the sensory appeal the better (a) the utilitarian attitude ($\beta = 0.352$, $p < 0.01$) and (b) the hedonic attitude ($\beta = 0.186$, $p < 0.05$) towards organic PCP, while a higher quality perception only improved the functional dimension of attitude (H5a; $\beta = 0.354$, $p < 0.01$) and not the affective one (H5b not supported). Contrary to what hypothesised (H6), the price evaluation did not significantly impact on the attitudinal dimensions. Finally, the intention to buy organic PCP increased with the increasing in the hedonic attitude ($\beta = 0.269$, $p < 0.01$) and, mostly, in the utilitarian attitude ($\beta = 0.650$, $p < 0.01$) towards these products, thus supporting H7a and H7b.

Fig. 2: Structural model with standardized coefficients



* $p < 0.05$; ** $p < 0.01$

Source: our elaboration

6. Discussion and Conclusion

The present study proposed and tested a comprehensive buying behaviour model in order to identify the way of nudging consumers to choose organic personal care products. Based on the S-O-R framework (Mehrabian and Russell, 1974), it examined how attributes related to the consumers' experience with organic PCP (Stimulus) lead to consumers' attitudes (Organism) and, consequently, to behavioural intentions (Response). Data collected from Italian consumers were used to pursue this research goal.

Results confirm that attitude is a strong predictor for purchase intention. In this manner, as the attitude towards organic PCP increases positively, so does the intention to buy. This result is in line with the classical attitude-behaviour theory (Azjen, 1991; Ajzen and Fishbein, 2005) and previous studies in the context of organic cosmetics (Ghazali *et al.*, 2017; Hansen *et al.*, 2012; Mombeini *et al.*, 2015; Yeon and Chung, 2011). However, differently from previous research, the current study enriched the literature knowledge employing a bi-dimensional approach to attitudes. To adequately reflect consumers' cognitive and affective internal states based on the S-O-R model, both utilitarian and hedonic attitude towards organic PCP are considered as predictors of purchase intention. Findings showed that the major driver of buying intentions is utilitarian attitude, established by favourable perceptions of the effectiveness, helpfulness and functionality attributes of organic PCP. The effect of hedonic attitude was also significant and positive.

According to Matić and Puh (2015) findings, the environmental aspect did not contribute to the consumer's attitude towards organic PCP. This result is different from those of other studies, which

assert that concern for one's health and for the environment are the two most commonly-stated motives for purchasing organic cosmetics (e.g. Ghazali *et al.*, 2017; Yeon and Chung, 2011). In the present research, only the safety aspect, measured as natural content of organic PCP, had a significant impact on utilitarian attitude towards these products.

Results also showed that subjective knowledge of organic PCP determine the consumer's positive utilitarian and hedonic attitude towards these products. This reflects that if consumers perceive themselves having good familiarity and understanding of the features and benefits of organic PCP, they are more likely to generate positive attitudes, which in turn lead to a greater purchase intention.

Finally, the proposed theoretical model sheds light on the role of other relevant variables which affect the organic PCP choice and that have been neglected in past research. Specifically, as quality perception positively impacted the functional attributes associated to organic PCP (utilitarian attitude), the improvement in sensory appeal evaluation significantly increases both the utilitarian and hedonic attitudinal dimensions.

This study provides both theoretical and managerial contributions. Theoretically, it showed that the S-O-R model is a solid framework for the purpose of the study. Moreover, it advances the understanding of consumer buying behaviour in the context of organic PCP. Considering a broad system of relations, it fills the lack of knowledge regarding a more grounded exploration of the decision-making process towards these products.

Managerially, the study provides manufacturers and retailers several implications for the development of effective strategies to the organic PCP market. Regarding the determinants of the attitude towards these products, protection of the environment seems not a priority for the consumers. Therefore, practitioners wishing to gain more market share as regards the organic PCP must consider factors other than ecological welfare which can motivate the consumers to develop positive perceptions towards such products.

The findings suggest that creating a positive attitude towards organic PCP may be a significant consideration for companies to consequently increase consumers' purchase intentions. Specifically, the major driver of buying intention is utilitarian attitude, established by favourable perceptions of the natural content, quality and sensory characteristics of organic personal care products. Contextually, previous experience and perceived knowledge of the benefits and features of organic PCP are important to influence both utilitarian and hedonic attitude. Therefore, when communicating the utilitarian (effectiveness and functionality) and the hedonic (fun, excitement, pleasure) dimensions of the organic personal care products consumption, companies should stress their natural attributes (no additives, no GMOs, no synthetic perfumes) and the pleasantness of sensory aspects like texture and perfume. Moreover, retailers and manufacturers can help consumers develop more positive perceptions of organic PCP by increasing their familiarity with these products. To achieve this goal, they should use miniature samples as a marketing tool to induce trials. Similarly, the use of product testers in store should provide tactile cues for the sensory evaluation. According to McCabe and Nowlis (2003), consumers' direct experience with a product plays a fundamental role in making purchase decisions. If consumers evaluate the sensory attributes of organic PCP as pleasant and develop a high quality perception even before the purchase, they are more likely to improve their attitude toward such products, which in turn can positively influence the purchase intention. Clearly this lever cannot be exploited in the online retail channel, in which rich and elaborate descriptions are the better way to overcome the consumer's desire for direct sensory experience.

The proposed strategies can be useful to both persuade the non-buyer and reinforce the purchases of who is already a buyer of organic PCP. Greater knowledge and better perceptions about these products will not only induce new individuals to buy them but will also increase the level of consumption among existing consumers. For non-consumers, the marketing campaign should mainly point out the quality and the natural content benefits of organic PCP. For consumers, instead, campaigns should also stress the past experience and the experimented sensory benefits.

7. Limitation

Despite the literature contribution, the present study has some limitations. First, the recruitment method and the sample size prevent from generalizing the results. Therefore, further research is recommended in order to extend the investigation to a larger sample that is representative of the general population. The increasing in sample size will also allow verifying the robustness of the model. Second, only purchase intention was measured, not actual behaviours. In addition to measuring purchase behaviour through self-report measures, it would be interesting to make an in-depth daily survey in order to investigate the actual consumers' purchase of organic personal care products. Third, although perceived expansiveness of organic PCP did not affect the attitude formation, it would be appropriate investigate if it impacts on behavioural interventions. Therefore, the direct relationship between price and purchase intention should be included in the proposed model. Finally, longitudinal studies are required to examine whether changes in consumer attitude, perception and buying with regard to organic PCP happen in time.

Appendix A: Items of the questionnaire

Construct	Items	Authors
Knowledge about organic PCP	I know a lot about organic personal care product I have great purchasing experience with organic personal care product I am familiar with organic personal care product I understand the features and benefits of organic personal care product My knowledge about organic personal care product is better relative to the people that I know	*Park et al.,1992*
Natural content	Organic personal care products contain no additives Organic personal care products contain natural ingredients Organic personal care products contain no GMOs and synthetic fragrances	*Steptoe et al., 1995*
Sensory appeal	Organic personal care products look nice Organic personal care products have a pleasant texture Organic personal care products smell good	*Steptoe et al., 1995*
Product quality	Organic personal care products products have higher quality than conventional	*Gracia and De Magistris, 2007*
Price	Organic personal care products are expensive The price of organic personal care products is high	*Yoo et al., 2000*
Utilitarian attitude	Ineffective-effective Not helpful-helpful Not functional-functional	*Voss et al., 2003*
Hedonic attitude	Unnecessary-necessary Not fun-fun Dull-exciting Not delightful-delightful Not thrilling-thrilling	*Voss et al., 2003*
Purchase intention	If organic personal care products were available in the shops, I would buy them I am willing to buy organic personal care products despite their higher prices The probability I would buy organic personal care products is very high	*Teng and Wang, 2015*

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Towards a framework for understanding recycling behavior in higher education institutions

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Abstract

Objectives. *This paper aims to provide a systematic literature review about recycling behaviors in higher education institutions to gather up and synthetize the extant knowledge on this topic into a comprehensive framework. More specifically, this study carries out a basic understanding of the research topic and identifies the factors affecting recycling intentions/behaviors in higher education institutions.*

Methodology. *A systematic literature review of existing research is conducted. A total of 64 journal articles published between 1995 and 2019 are analyzed in five steps: obtaining basic understanding, coding, categorization, comparison, and further analysis.*

Findings. *This study identifies environmental concern, attitude towards recycling, social norms, university environmental policy, and availability of recycling facilities provided at higher education institutions as the factors affecting recycling intentions/behaviors in higher education institutions.*

Theoretical and practical implications. *Scholars can use this paper as reference to systematize knowledge about recycling behavior in higher education context and further advance knowledge on this topic by identifying specific research areas that can be theoretically and empirically investigated. University managers can use the to use the factors affecting recycling intentions/behaviors emerged by this study as a basis for designing behavioral intervention programs in their higher education institutions.*

Originality of the study. *No systematic literature review about the recycling behaviors in higher education setting has previously been undertaken.*

Key words: *sustainability; students; university policy; environmental awareness and concern; attitude towards recycling; social norms*

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1. Introduction

Public debate about how to reduce the waste problem for the conservation of natural resources is more and more intense. A general awareness of the environmental consequences of waste is in action, also in legislative terms. Recycling is commonly mentioned as one of the preferred methods of waste reduction (Virtanen and Nilsson, 2013). Generally, there is an increasing awareness of the environmental impact of consumer behavior (Oguz *et al.*, 2010) and the importance of recycling as an effective resource-recovery mechanism in relation to economic and environmental benefits. Accordingly, a number of marketing scholars and specialists are interested to better understand these pro-environmental behaviors in different analysis contexts.

Higher education institutions such as universities have a moral responsibility to contribute to sustainability (Cortese, 1992). This further develops if they are aimed at achieving sustainable resource use as their corporate mission. In this direction, universities have recently started to pay an increasing attention to improve environmental policies and recycling facilities in their campus (e.g., Wan *et al.*, 2012; Izagirre-Olaizola *et al.*, 2015). A number of green activities are undertaken by many universities to respond to the rapid development of student, staff and support infrastructures numbers that demand many resources such as energy and paper (e.g., Marcell *et al.*, 2004; Amutenya *et al.*, 2009; Altan, 2010; Mtutu and Thondhlana, 2016). As some scholars argued, universities can be considered as communities that significantly influence wider society (Kaplowitz *et al.*, 2009) and they can, consequently, maintain pro-environmental behavior (Kelly *et al.*, 2006).

With specific reference to studies about recycling, that is one of the key strategies to develop a sustainable university campus (e.g., Smyth *et al.*, 2010), there is a need to improve understanding of recycling behaviors, because successful recycling programs demand both technology and the involvement of people (Kelly *et al.*, 2006). To the best of our knowledge, recycling behaviors are explored in fragmented way in the "business management and accounting" research subject area included in the Scopus database. More precisely, previous research fundamentally examined this topic with reference to specific countries or universities. Each of these studies highlighted the results that were emerged by surveys carried out in such contexts. Accordingly, there is a lack of unitary vision about this topic to try to predict recycling behavior.

By reviewing previous journal articles through a systematic approach, the purpose of this study is to gather up and synthetize the extant knowledge on the recycling behaviors in higher education context into a comprehensive framework. In this regard, after carrying out a basic understanding of the research topic, the factors affecting recycling intentions/behaviors in higher education institutions are identified. Finally, future research directions are proposed.

The findings of this systematic literature review will contribute theoretically and practically. On the one hand, they will enable scholars to not only systematize knowledge about recycling behavior in higher education context but also further advance knowledge on this topic by identifying specific research areas that can be theoretically and empirically investigated. On the other hand, the results of this study will provide managerial implications for supporting the adoption of more sustainable behaviors and suggest to university managers to use the factors affecting recycling intentions/behaviors as a basis for designing behavioral intervention programs in their higher education institutions.

In relation to the structure of this paper, the next section describes the methodology employed in the study, explaining how the materials were collected, selected and analyzed. Following this, the descriptive results of the analysis are presented (years of publication, journals, and studies' research methods) and factors that affect recycling intentions/behaviors in higher education institutions are proposed. Subsequently, directions for future studies about recycling behavior are considered. Finally, this study concludes by underlining some limitations of the study.

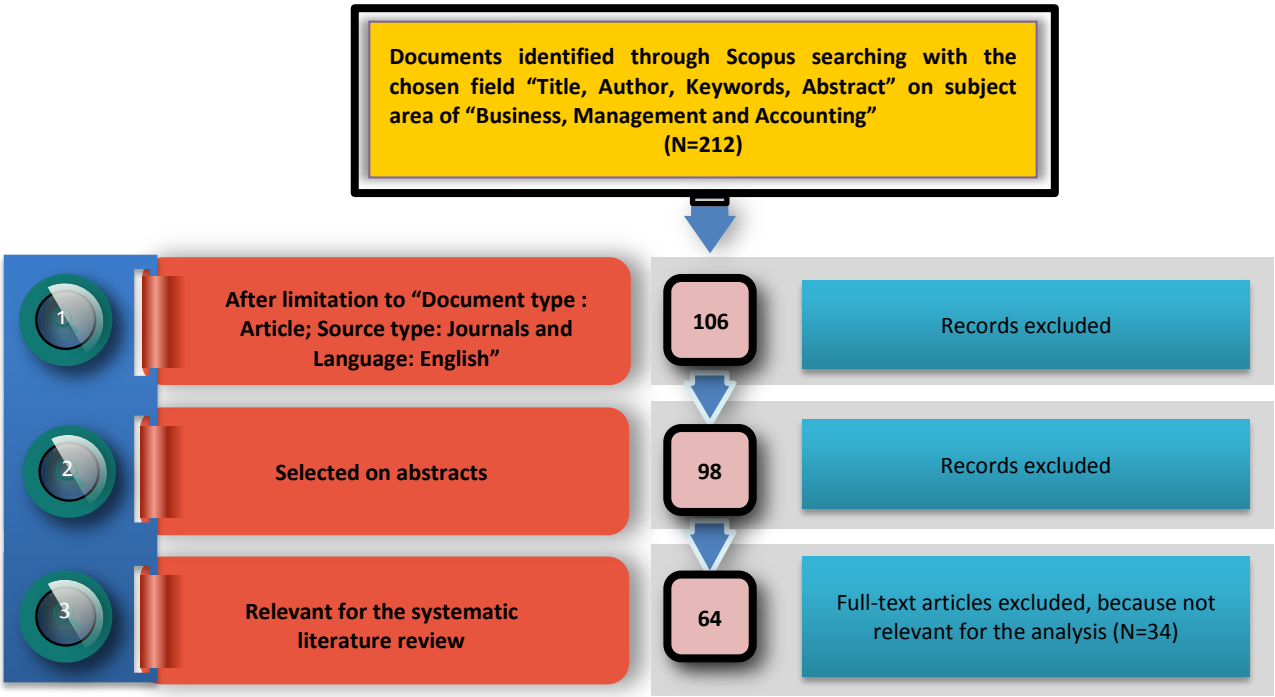
2. Methodology

This study employs a systematic literature review as methodological approach. This specific method, that provides a transparent and dependable evaluation of the topic under examination, enables to address new or emerging topics, monitor progress in a research field, promote knowledge building, understand a phenomenon, and clarify unexplored research topics (e.g., Booth *et al.*, 2012; Lightfoot *et al.*, 2013). For the review were adopted the four following steps proposed by Denyer *et al.* (2009) and Merlì *et al.* (2018): a) formulation and definition of clear research questions and keywords; b) definition of inclusion criteria; c) selection and evaluation of materials; and d) analysis and synthesis of the selected material.

The articles on recycling behavior in higher education institutions was selected in database of Scopus, which is defined by Merlì *et al.* (2018) as one of the most authoritative and comprehensive databases in the scientific research. The searches were performed using the following keywords "waste recycle*" OR "separate collection" OR "separate waste collection" OR "recycle*" along with the keywords that are expression of the analysis setting ("campus" OR "university" OR "college" OR "higher education institutions"). Each search was carried out in the "Title, author, keywords, abstract" field. Although this topic is analyzed in different research subject areas such as chemistry, medicine, engineering, and psychology, the current paper focuses on the "business, management and accounting" subject area. The records identified through Scopus searching were 212 documents. After the first selection, for the final sample of review were considered only articles published in academic journals and are written only in English, since it is an executive language for the research (Merlì *et al.*, 2018). Consequently, the half (106 documents) out of 212 documents on recycling behaviors was removed.

After the selection and evaluation of materials, the remained papers (n=106) were analyzed more in detail. The abstracts were scanned in order to keep the search process in line with the objectives of this study and 8 articles were excluded, because they were not relevant for the analysis. After a reading of full articles remained (n=98), other 34 articles were removed, because not relevant for the study. The remaining 64 articles were selected for the systematic literature review and in order to be better analyzed, were replaced on a single excel sheet. Figure 1 gives an overview of the selection process.

Fig. 1: Selection process



Source: Our elaboration

In order to provide a basic understanding of the topic, articles were coded in relation to both publication's trend per year and journals. Also, the distribution of selected papers was analyzed in relation to article type (conceptual, empirical or general review) and research method (qualitative, quantitative or mixed).

In order to identify the factors affecting recycling intentions/behaviors in higher education institutions, content analysis of the 64 articles was undertaken (Stemler, 2001). Thematic coding of this material was inductively undertaken (Saldana, 2009) in relation to the research purpose. The coding was conservatively undertaken, given that it included only what was explicit in the data. In other words, intentionality was not inferred in the data. The themes, that include relevant factors influencing recycling behavior, were distinguished into the five following categories: a) environmental concern; b) attitudes towards recycling; c) social norms; d) university environmental policy, and e) availability of recycling facilities provided at higher education institutions.

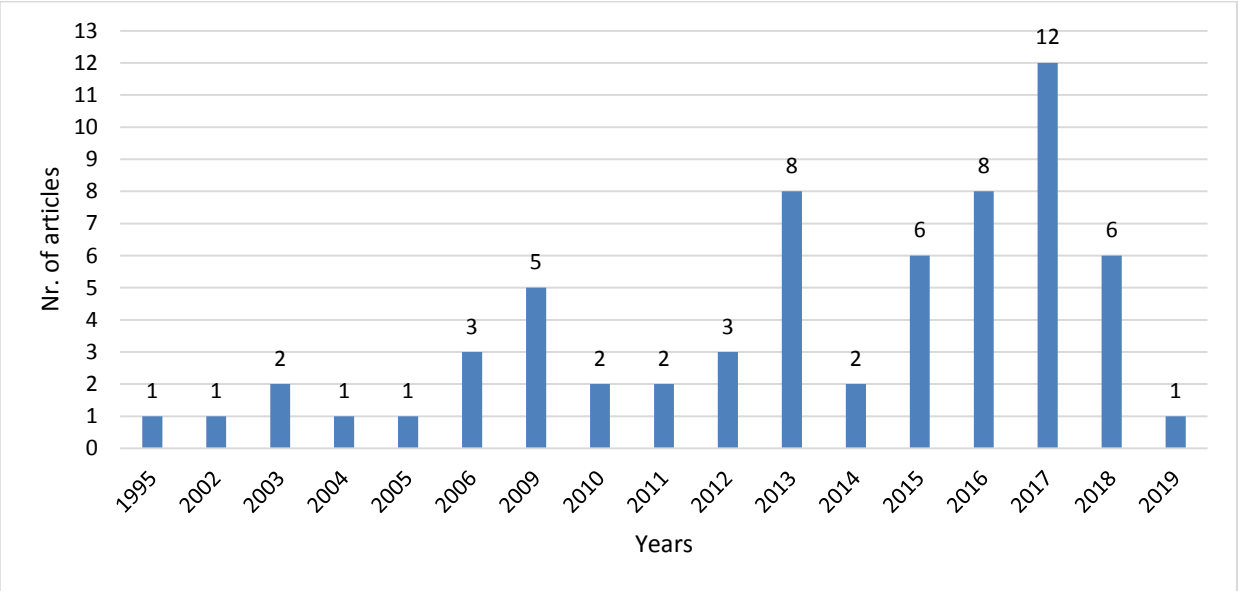
3. Findings

In this section, the descriptive findings are first presented. More precisely, section 3.1 describes the distribution of the publications over time and among journals, the type of article (conceptual, empirical or review), and the methodologies that are adopted (qualitative, quantitative or mixed). After that, section 3.2 presents the main factors affecting recycling behaviors in higher education institutions as emerged from the literature analysis.

3.1 A basic understanding of the research topic

The analysis of the selected papers revealed that the first study on recycling behaviors in higher education institutions dates back to 1995 (Shim, 1995). The subsequent article identified in the data set under analysis was published only in 2002, thus suggesting limited academic interest for this field of research in the second half of the 1990s. In Figure 2, which presents the distribution of the articles over time, a sharp increase in publications can be observed for the period 2015-2018. About half (51,6%) of selected papers were published in these four years. The most productive year for research on this topic was 2017, when 12 articles (18,8%) were published. In the first months of 2019, only one article has been published.

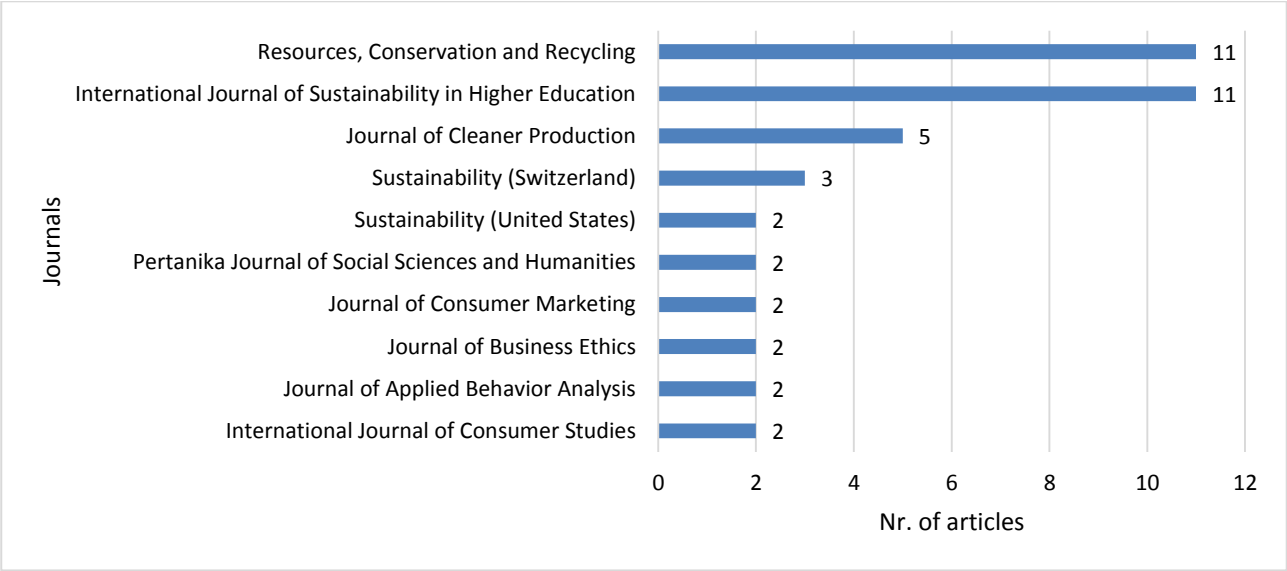
Fig. 2: Distribution of publications about recycling in higher education institutions over time



Source: Our elaboration

With regard to the journals, the articles in the unit of analysis belong to a total of 32 different journals related to the "Business, Management and Accounting" subject area, and more specifically to marketing, consumer behavior, environment and sustainability. *Resources, Conservation and Recycling* and *International Journal of Sustainability in Higher Education* are the two journals with the highest number of published articles (11) on this topic. Figure 3 presents the journals with at least two published articles.

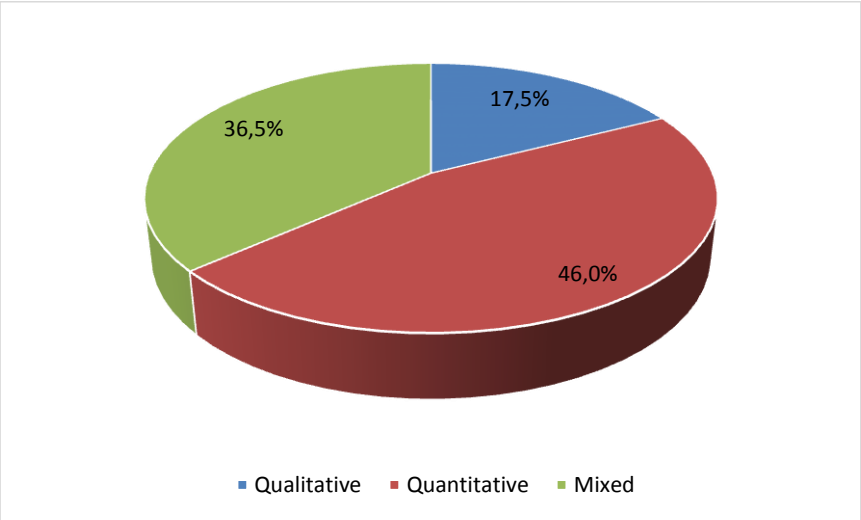
Fig. 3: Distribution of publications among journals (journals with at least 2 published articles)



Source: Our elaboration

In terms of article type (conceptual, empirical or review), a lack of conceptual and review paper was verified. In fact, all the selected papers for the literature review are empirical. From a methodological perspective, 17.5% of empirical studies adopt a qualitative approach, 46.0% adopt a quantitative approach, and 36.5% use a mixed-method approach (qualitative and quantitative methodologies). A high percentage of researcher, prefer to adopt a mixed approach, combining both qualitative and quantitative methodologies, in order to better explain the recycling behavior in university context (Figure 4).

Fig. 4: Distribution of publications based on research methodology



Source: Our elaboration

3.2 Factors affecting recycling intentions/behaviors in higher education institutions

Thematic analysis revealed five major factors affecting recycling intentions/behaviors in higher education institutions. Specifically, the following themes were identified: a) environmental concern; b) attitudes towards recycling; c) social norms; d) university environmental policy, and e) availability of recycling facilities provided at higher education institutions. After presenting the results of thematic analysis, some socio-demographic characteristics associated to higher recycling rates are proposed.

1) A number of studies identify environmental concern among the most important elements in the development of a positive attitude toward recycling. This theme includes a variety of more specific topics, such as environmental awareness, environmental knowledge and environmental values, as Table 1 shows. More precisely, awareness of environmental pollution was found to be a driver of college students' recycling behaviors in a study conducted at a Chinese university (Zhang at al., 2017). Awareness of environmental consequences was also found to encourage eCycling, i.e. the recycling of electronic waste, among college students (Gonul *et al.*, 2016). Environmental awareness is also important to improve academic and non-academic staff recycling rates (Aksan and Çelikler, 2017; Davis *et al.*, 2009). In a cross-country comparative analysis, Izagirre-Olaizola *et al.* (2015) show that environmental knowledge is a useful factor for predicting university students' recycling behaviors. In terms of electronic waste, environmental concern motivates students to use the specific recycling bin (Jiménez-Parra *et al.*, 2014). Eco-concern favors pro-environmental behaviors of college students while traveling (Han and Hyun, 2018). Joung *et al.* (2013) conducted an empirical analysis at a Southeastern US university and the results showed that environmental concern influences the resale and the donation of clothes by students. In another study to test whether university students were likely to reduce their on-campus waste stream, Flagg and Bates (2016) found that environmental values were associated to self-reporting higher levels of recycling effort. In a recent study by Felix and Almaguer (2019) that was conducted with college students, a feeling of psychological ownership of the planet Earth was positively associated to both recycling and green purchasing. In a study to explore the connections students make between their food-related choices and the environment and the actions that can be undertaken to ameliorate negative environmental outcomes associated with modern food practices, having a pro-environmental worldview was associated with recycling and reducing food waste (Campbell-Arvai, 2015). Environmental awareness however may not be enough and other studies show that even if university students are aware of the importance of recycling, their attitudes and behaviors are conflicting (Basri *et al.*, 2016). In a study to explore students' assessment of campus sustainability components, it was found that even if students indicate environmental awareness and concern, they lack willingness to participate in environmental initiatives (Abubakar *et al.*, 2016). From an empirical analysis conducted in Oxfort it emerged that such students do not have a high level of recycling (Robertson and Walkington, 2009). Also, in the textile context, materialistic customers which consider clothes as a symbol of prestige, success and social status (Browne and Kaldenberg, 1997) are not interested in environmental issues, but their participation in recycling is the same as the non-materialistic customers. With this respect, in the Vitell and Muncy's study, a group of college students was compared with not-students in terms of recycling and environmental awareness, and there were not verified differences between the two groups (Vitell and Muncy, 2005). Thematic analysis also revealed that the lack of or a low environmental awareness displays a negative relation with recycling in higher education institutions. In a study to develop a checklist of green culinary behaviors and to examine green culinary behaviors of hospitality students, Wang (2016) found that many students perform non-green behaviors, i.e. kitchen waste, mainly because of low environmental awareness. Another research found that university students have only moderate environmental awareness and therefore only sometimes practice recycling (Omran *et al.*, 2017). Alves and Farina (2018) in a study to identify factors that influence e-waste management at a Brazilian university affirm that more environmental awareness is needed. The results of Kaplowitz *et al.* (2009) report that the lack of knowledge about the environmental benefits that derive from

recycling has a negative influence on properly recycling. The lack of knowledge about the consequences in environment negatively influences recycling behaviors also for the non-academic staff of university (Davis *et al.*, 2009).

2) A second theme emerged from the analysis includes the attitude toward recycling. In an empirical study to examine the antecedents of the proper disposal of used batteries at a university campus, Apinapath *et al.* (2015) found that a positive attitude toward recycling is a relevant predictor of students' recycling intentions. Positive attitudes toward recycling also affect recycling of electronic waste among college students (Gonul *et al.*, 2016) and favor pro-environmental behaviors of college students while traveling (Han and Hyun, 2018). In a field experiment conducted at a university, people's positive attitudes toward the environment were found to facilitate the implementation of an accounting model to monitor waste production (Gallo *et al.*, 2017). However, in contrast with previous studies, Joung (2013) found that positive environmental attitudes do not positively affect the participation in recycling.

3) The third theme emerged from the analysis of the factors affecting recycling intentions/behaviors is represented by social norms, understood as the external influence students are exposed to. Social norms, in the sense of "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p. 188) are associated to pro-environmental behaviors of college students while traveling (Han and Hyun, 2018). In a study about the use of e-learning platforms in embedding sustainability concepts in higher education, Sanganyado and Nkomo (2018) found that e-learning activities and discussions were promoting chemistry and engineering students' engagement in sustainability, because they could learn about their peers' sustainable practices. Apinapath *et al.* (2015) also found that exposure to environmental information from professors and peers is a relevant predictor of students' recycling intentions. Family members, parents and friends positively influence the recycling behavior of students (Robertson and Walkington, 2009). The positive influence of surrounding friends as an antecedents of students' recycling behaviors is also reported by Zhang *et al.* (2017). Moreover, students are motivated by family norms to resale and donate their clothes (Joung *et al.*, 2013).

4) The fourth theme emerged from the analysis, which was named university environmental policy, includes for example the organization of projects, initiatives or academic courses related to environmental issues. In order to involve more students in recycling, universities may promote recycling activities encouraging students to participate. Being part of such projects, student will better understand the importance of recycling and how to correctly recycle (De Vega *et al.*, 2003; Mason *et al.*, 2004; Smyth *et al.*, 2010; Kurland, 2011; Baldwin and Dripps, 2012; Md Zain *et al.*, 2012; Barros et al; 2013; Cole and Fieselman, 2013; Posey and Webster, 2013; Md Zain *et al.*, 2013; Becker *et al.*, 2014). Recycling programs which explain clearly what, how and where to recycle and do not focus a lot on why to recycle, motivate students to become good recyclers (Kaplowitz *et al.*, 2009). The initiative of green building in College of Charleston, South Carolina, USA changed the recycling behavior of students, since this project provided additional information about recycling rules (Owens and Halfacre-Hitchcock, 2006). In a case study at a Brazilian university to discuss the implementation of a waste management plan, Fagnani and Guimarães (2017) found that percentages of waste were significantly lower after the implementation of the plan, and even lower after students and staff were involved in a waste minimization awareness campaign. Maldonado (2006) showed quantitatively that the participation in a program for the minimization and recycling of solid waste not only enhanced the environmental awareness but also reduced significantly (around two thirds) the amount of waste. Another study, performed at one of the US leading universities for green initiatives, shows that the level of students' sustainable practices is higher if they have taken academic courses related to environmental sustainability (Choi *et al.*, 2017). As De Vega *et al.* (2003) mentioned in the case of Mexico, the lack of environmental education negatively influences the active participation of students in recycling. In a study to identify best practices of successful sustainability programs at different universities, Tahara *et al.* (2015) found that educational efforts, a full-time Sustainability Coordinator as well as student volunteers were identified among core elements of sustainability programs. In a survey to university

staff, Brennan *et al.* (2015) shows that action plans and staff training can really improve sustainability implementation into university operations. Training teachers was also found to improve e-waste recycling rates (Bitanga, 2017). In university contexts, where the level of paper usage is very high, a small reduction of used paper will reduce significantly the amount of waste stream. For example, the replacement of printers with double-sided printer reduces by the half the total amount of paper used. In this way, having a new and sustainable opportunity, university members are encouraged to recycle and in the same time to improve their recycling behavior (Amutenya *et al.*, 2009). At the Swansea University, UK, an experiment was realized proposing reusable cups with a discounted price. The main objective was to analyze the staff and student attitudes towards such new option. From the results it emerged that such "financial incentive" brings to a higher rate of university members which use refillable mugs (Harris and Probert, 2009). Technology can also be considered a tool to involve in sustainability issues, as in the study conducted by Mozo-Reyes *et al.* (2016), where the implementation of technological bins at a university produced an increase in recycling through interactivity and feedbacks, that made recycling more attractive to students. However, even if these studies show that environmental education reduces the amount of waste stream, the results of an experiment organized by professors at a US university demonstrated how the presence of recycling education does not influence the increase of recycling in students' apartments (Pike *et al.*, 2003).

5) The last theme emerged from the analysis concerns the quality of recycling facilities provided at university. With regard to this topic, two specific issues emerged: the availability of recycling bins and the availability of information and guidelines on how to correctly use them. Related issues of time constraints and effort constraints also emerge in this respect. As an example, the lack of bins represents a circumstantial limitation to the proper disposal of used batteries among college students (Apinhapath *et al.*, 2015). The lack of recycle bins for electronic waste does not permit to the students to recycle such kind of waste (Löbler *et al.*, 2012). Quality of recycling facilities may consist not only in the lack of bins but also in the wrong positioning of bins, as demonstrated by a behavioral study in which a significant increase in recycling is reported with centrally located recycling bins (Binder *et al.*, 2017). In a study on the strategies to enhance waste management activities at university campuses, Ebrahimi and North (2017) report that identifying new locations for placing bins may be an effective strategy since the lack of access to a sufficient number of bins in university campuses represents one of the main barriers to recycling. Another study shows that if the recycling bins are placed in classrooms or in common places, the level of recycling increases (O'Connor *et al.*, 2010). Similar results are provided by a quasi-experimental study performed in a university residential hall (Cheung *et al.* 2018) where after the installation of a new plastic recycling bin, students' pro-environmental behaviors increased. Two more experimental studies lead to similar conclusions: in an experiment with university students, staff and visitors (Fritz *et al.*, 2017), recycling bins were placed close to trashcans and recycling rated increased. In another experiment (McCoy *et al.*, 2018), modifications were made to the location of waste and recycling containers and recycling improved significantly. The findings of a survey with the students in Texas highlighted the need for additional recycling bins in the places where they are not present in order to enhance waste recycling in the university. Furthermore, it is necessary to put plastic recycling bins not only outside the campus but also inside, especially near the vending machines (Beard, 2002). An inadequate and unbalanced distribution of recycling bins in universities makes it more difficult the recycling by students and staff (Geng *et al.*, 2013; Marquardt *et al.*, 2013). In an experiment in USA it was showed that the willingness of students to recycle in their apartments enhances if they have the opportunity to have recycling bins inside their structure (Pike *et al.*, 2003). Differently from private houses, in students' residences it is difficult to find recycle bins and the rate of recycling is low. This difficulty influences directly recycling behavior of students (Robertson and Walkington, 2009). A dispersed campus structure and the low availability of bins are also reported as preventing recycling in a case study conducted by Weaver *et al.* (2015). Zhang *et al.* (2017) found that a good waste separation infrastructure is closely related to students' waste recycling behaviors. Focusing on the kitchen/cafeteria of the university campus, Mason *et al.*

(2004) noted that the limited space hinders the students to recycle. Recycling bins are outside the building, so for them it is easier to throw waste in dustbin. Convenience of available recycling facilities, in the sense of time and ease, is an important factor that leads to more students' involvement in eCycling behaviors (Gonul Kochan *et al.*, 2016), Time constraints have also been reported as preventing students' willingness to participate in environmental initiatives in a pilot study by Zain *et al.* (2016). In addition, Campbell-Arvai (2015) shows that behaviors that require low effort or little substantial change are generally associated to students' food-related choices, such as reducing food waste and recycling. In another study on food-related behaviors, Wang (2016) reports that many students perform non-green behaviors, such as running water when not necessary, only because this requires less effort. Availability of practical information and guidelines on how to recycle is also found to affect recycling intentions/behaviors in higher education institutions. In a case study at a large university, Weaver *et al.*, (2015) found that recycling is strongly influenced by the university context and by the process designed to promote recycling itself. In particular, information on written posters was deemed important to promote recycling behavior. A general lack of information on how to recycle adequately is often reported (Beard, 2002; Owens and Halfacre-Hitchcock, 2006; Kaplowitz *et al.*, 2009). As a consequence, the lack of guidelines or the ambiguity of the provided information prevents students from recycling (Kelly *et al.*, 2006). Some clear indication marks could facilitate students' recycling (Geng *et al.*, 2013). Information on how to distinguish and correctly classify waste is also reported as a factor that influences students' recycling behaviors (Zhang *et al.*, 2017). In another case, in Michigan State University campus, students and staff assumed that it is not so clear which item is possible to recycle within the campus. Also, they noted that they are aware of the availability of recycling bins, but not of their precise location inside the campus (Olson *et al.*, 2011). Guidelines and correct signage were also identified in other research as low-cost initiatives that could be implemented to enhance recycling rates in universities both for students (Cheung *et al.*, 2018) and for university staff (Ebrahimi and North, 2017). In a comparative study by Ferronato *et al.* (2017), a general lack of knowledge was deemed responsible for low recycling rates in universities. Moreover, in a research to explore the application of special recycling bins, a general lack of obstacles is reported as a necessary condition to improve waste separation practices (Supakata, 2018).

Lastly, several studies provide evidence regarding some socio-demographic characteristics associated to higher recycling rates. Female university students generally display more environmental behaviors and engagement in recycling activities (Campbell-Arvai, 2015; Flagg and Bates, 2016; Izagirre-Olaizola *et al.*, 2015; Meyer, 2016; Zhang *et al.*, 2017). In an exploratory study with the undergraduates in a large-sides Southwestern university conducted by Shim (1995), the role of gender, age and ethnicity on waste recycling behavior was analyzed. A strong relationship emerged, where female students and older students are more predisposed to adopt environmentally methods. The same findings are found in other studies focusing on the non-academic staff (Davis *et al.*, 2009; Robertson and Walkington, 2009). In the case of experiment with reusable cups with a lower price, female students use more this kind of cups (Harris and Probert, 2009). With respect to age, younger members of academic staff are found to pay less attention to the recycling methods at work (Davis *et al.*, 2009). Meyer (2016) found that the probability of environmental behaviors increases with each year of college education. Ethnic minorities were also found more likely to be engaged into recycling activities. On the contrary, the analysis of Shim (1995) pointed out that white students are more interested/careful with respect to the environment than non-white students. Religiosity, on the other hand, seems to display no effects on recycling rates at university (Arli, 2017). Finally, as Davis *et al.* (2009) demonstrated with a survey that married participants and participants who were parents recycled more at home and at work with respect to other participants.

Table 1 synthetizes factors influencing recycling intentions/behaviors in higher education institutions emerged by literature review, in addition to socio-demographic characteristics associated to higher recycling rates.

Tab. 1: Factors influencing recycling intentions/behaviors in higher education institutions

Environmental concern	
Environmental concern	Browne and Kaldenberg, 1997; Joung at al., 2013; Jimenez-Parra *et al.*, 2014; Abubakar *et al.*, 2016; Han and Hyun, 2018
Environmental awareness	Vitell and Muncy, 2005; Davis *et al.*, 2009; Robertson and Walkington, 2009; Basri *et al.*, 2016; Wang, 2016; Abubakar *et al.*, 2016; Aksan and Celikler, 2017; Omran *et al.*, 2017; Alves and Farina, 2018
Awareness of environmental pollution	Zhang *et al.*, 2017
Awareness of environmental consequences	Davis *et al.*, 2009; Gonul *et al.*, 2016
Environmental knowledge	Kaplowitz *et al.*, 2009; Izagirre-Olaizola *et al.*, 2015
Environmental values	Flagg and Bates, 2016
Psychological ownership	Felix and Almaguer, 2019
Pro-environmental worldview	Campbell-Arvai, 2015

Social norms	
Friends Family Peers Professors	Robertson and Walkington, 2009; Joung *et al.*, 2013; Apinapath *et al.*, 2015; Zhang *et al.*, 2017; Sanganyado and Nkomo, 2018; Han and Hyun, 2018

Attitudes	
Attitudes towards recycling	Joung, 2013; Apinapath *et al.*, 2015; Gonul *et al.*, 2016; Gallo *et al.*, 2017; Han and Hyun, 2018

University environmental policy	
Waste minimization activities	De Vega *et al.*, 2003; Mason *et al.*, 2004; Maldonado, 2006; Owens and Halfacre-Hitchcock, 2006; Kaplowitz *et al.*, 2009; Smyth *et al.*, 2010; Kurland, 2011; Baldwin and Dripps, 2012; Md Zain *et al.*, 2012; Barros et al; 2013; Cole and Fieselman, 2013; Posey and Webster, 2013; Md Zain *et al.*, 2013; Becker *et al.*, 2014; Fagnani and Guimaraes, 2017
Specific examples: Double-side printers Reusable cups Technological bins	 Amutenya *et al.*, 2009 Harris and Probert, 2009 Mozo-Reyes *et al.*, 2016
Environmental education	De Vega *et al.*, 2003; Pike *et al.*, 2003; Tahara *et al.*, 2015; Choi *et al.*, 2017
Staff training	Brennan *et al.*, 2015; Bitanga, 2017

Recycling facilities	
Availability of recycling bins	Beard, 2002; Pike *et al.* 2003; Robertson and Walkington, 2009; O'Connor *et al.*, 2010; Löbler *et al.*, 2012; Geng *et al.*, 2013; Marquardt *et al.*, 2013; Apinapath *et al.*, 2015; Weaver *et al.*, 2015; Ebrahimi and North, 2017; Fritz *et al.*, 2017; Binder *et al.*, 2017; Zhang *et al.*, 2017; McCoy *et al.*, 2018; Cheung *et al.*, 2018
Availability of information	Beard, 2002; Owens and Halfacre-Hitchcock, 2006; Kelly *et al.*, 2006; Kaplowitz *et al.*, 2009; Olson *et al.*, 2011; Geng *et al.*, 2013; Weaver *et al.*, 2015; Zhang *et al.*, 2017; Ebrahimi and North, 2017; Ferronato *et al.*, 2017; Cheung *et al.*, 2018
Time/effort constraints	Mason *et al.*, 2004; Campbell-Arvai, 2015; Wang, 2016; Gonul *et al.*, 2016; Zain *et al.*, 2016; Supakata, 2018

Socio-demographic characteristics	
Gender	Shim, 1995; Davis *et al.*, 2009; Robertson and Walkington, 2009; Harris and Probert, 2009; Campbell-Arvai, 2015; Izagirre-Olaizola, 2015; Flagg and Bates, 2016; Meyer, 2016; Zhang *et al.*, 2017
Age	Shim, 1995; Davis *et al.*, 2009; Robertson and Walkington, 2009; Meyer, 2016
Ethnicity	Shim, 1995; Meyer, 2016
Religion	Arli, 2017
Marital status	Davis *et al.*, 2009
Having children	Davis *et al.*, 2009

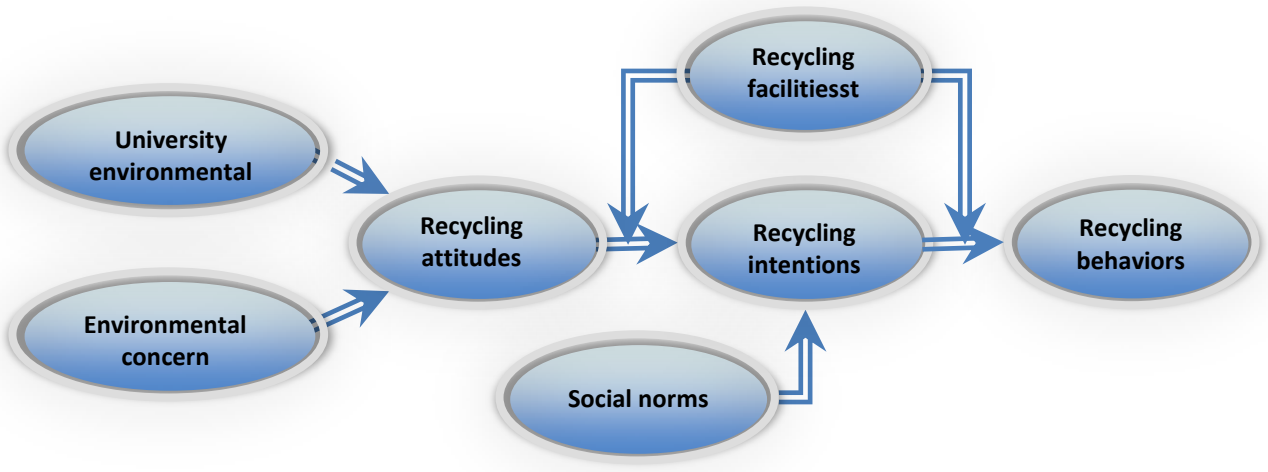
Source: Our elaboration

In order to systematize results, the factors influencing recycling intentions/behaviors in higher education institutions can be classified according to the Theory of Reasoned Action (TRA). The TRA, grounded in social psychology, was developed by Fishbein and Ajzen (1975) in order to explain behavioral intentions. Ajzen and Fishbein (1980) define such behavioral intention as a function of two determinants: person's attitude toward the action and person's social norms. Attitude refers to the evaluation of the performance of a specific behavior, while social norm is related to "perceived social pressure to perform or not perform a specific behavior (Ajzen 1991; Madden, Ellen and Ajzen, 1992). Intentions are then strongly related to performing a specific behavior (Fishbein and Ajzen, 1975).

The TRA has been widely used to study different contexts such as health behaviors, voting, organic food etc. (Netemeyer and Bearden, 1992; Lee and Green, 1991). Also, it has been adopted in the area of green marketing to explain environmentally-related behaviors such as recycling behaviors (Davies *et al.*, 2002) and green purchase behaviors (Ha and Janda, 2012; Wahid *et al.*, 2011; Sparks and Shepherd, 1992). Previous literature on recycling behaviors showed that recycling intentions are influenced by the willingness to recycle, convenience of available recycling facilities, attitudes toward recycling and social norms (Calvin *et al.*, 2012; Chu and Chiu, 2003; Kelly *et al.*, 2006; Sidique *et al.*, 2010; Tonglet *et al.*, 2004).

In the current study, we propose based on the TRA but adapted to the specificities of the higher education context. In particular, environmental concern and university environmental policies can be considered an antecedent of recycling attitudes. Attitudes and social norms affect recycling intentions, that in turn affect recycling behaviors. The availability of recycling facilities moderates the relation between recycling attitudes and intentions and recycling intentions and behaviors, as reported in Figure 5.

Fig. 5: TURRA Model



Source: Our elaboration

4. Future research directions and conclusions

The systematic literature review conducted in this study has revealed several literature gaps that represent important opportunities for future research directions.

A first gap concerns the determinants of recycling attitudes. From the literature analysis, university environmental policies and environmental concern emerged as key factors affecting attitude toward recycling. With reference to university policies, three interesting fields of research for future studies could be represented by the three following factors: a) the use of customer education activities, b) the use of social media communication, and c) the use of gamification techniques. First, customer education activities are educational initiatives undertaken to "better

educate, inform, and develop the knowledge and skills of the customers" (Antonios, 2011, p. 3; Brunetti and Bonfanti, 2017; Viassone *et al.*, 2018) about recycling. Such initiatives could be directed not only to students and higher institutions' personnel, but more broadly to the local community of stakeholders. In fact, stakeholder engagement represents an inclusive and bottom-up approach that could be more effective than traditional top-down approaches in developing policy design and implementation. Second, with regard to the use of online communication tools (e.g., Siano *et al.*, 2017), future research could explore the effect of social media communication in developing environmental knowledge, raising awareness about specific environmental issues and informing the community about the positive effects of recycling behavior. Finally, research could be directed to understand the potentialities of gamification to increase customer engagement toward recycling practices. Gamification can be defined as "the use of game design elements in non-game contexts" (Deterding *et al.*, 2011). More specifically, "Gamification is a developing approach for encouraging user motivation, engagement and enjoyment in non-gaming, computer-mediated environments" (Seaborn and Fels, 2015, p. 29). Recent studies have shown that gamification can be an effective tool to promote sustainable behavior in different context, such as tourism (e.g. Negrusa *et al.*, 2015) or urban mobility (e.g. Kazhamiakin *et al.*, 2015). There is a need to further explore the role of gamification to increase environmental concern and create a positive attitude toward recycling.

A second research gap that emerged from the literature analysis concerns the effect of social norms on recycling intentions. The majority of studies focused on peers, family members and friends. Future research could investigate if and how local community influences recycling intentions in higher education institutions. In other terms, it could be interesting to examine if and how the sense of community of who lives in a specific territory can lead to a more pro-environmental behavior by reporting different levels of recycling and, consequently, being willing to minimize waste. In this sense, local authorities can (or not) assume an important role.

Although some studies already explored the direct effect of recycling facilities on recycling intentions as well as on recycling behavior, a third research gap and future research direction is represented by the need to further investigate the moderating effect of recycling facilities on the relationship between attitudes and intention as well as on the relationship between intentions and recycling behavior. It is in fact proposed that recycling facilities can reinforce the effect of a positive attitude toward recycling on recycling intentions, as well as reinforce the effect of the willingness to recycle on the actual behavior.

Finally, some of the examined studies focused on recycling intentions without further investigating how intentions affect actual behavior, while other studies examined the direct effect of environmental concern, university policies or recycling facilities on behavior. Future research should adopt a more comprehensive approach by considering both the determinants of intentions and the factors influencing actual recycling behavior.

Some limitations of the analysis conducted should be acknowledged. First, data collection was limited to peer-reviewed articles present in Scopus. Even though this database provides a wide coverage of the academic literature, future studies could expand the data collection to other databases such as Web of Science or Google Scholar, to include recent conference contributions as well as other types of research reports. Second, future studies could include a wider set of keywords to expand the results to recycling behavior of millennials even outside higher education institutions. Finally, even though a rigorous analysis was conducted in order to reduce subjectivity in the identification of the themes, future studies could work on categorization with the support of software such as NVIVO.

To conclude, the study of the factors directly or indirectly affecting recycling intentions and behavior in higher education institutions represents a promising field of research. The recent development in technologies can stimulate new ways to engage customers and promote more sustainable behaviors among students, higher education institutions' personnel as well as among the broader community of stakeholders.

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Trust in green electricity: a measurement model

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Abstract

Objectives. *The aim of this paper is to contribute to literature on trust developing a model to measure trust of green consumers*

Methodology. *Based on a systematic literature review, previous measurement models of trust are summarised. Finally, trust in green electricity providers is operationalized by a thorough empirical process, resulting in a multi-factorial measurement model.*

Findings. *The results identify four dimensions influencing trust in green electricity market: competence, responsibility, openness and authenticity*

Research limits. *This research it is applied in the electricity market, so, it is particularly applicable to similar markets, despite some factors can be universal. Second, the data collection is located in Germany, although it is a developed economy and has a strong presence of ecological behaviour, it should be taken under account because cultural norms, values and perceptions influence customer behaviours*

Practical implications. *It opens different opportunities for managers showing what managerial practices can reinforce their environmental-friendly products or services offerings.*

Originality of the study. *This paper contributes to literature on trust developing a multi-dimensional measurement model reflecting the broad nature of the trust construct, specifically in the context of green electricity.*

Key words: *Green electricity; trust; exploratory factor analysis; competence; responsibility; openness; authenticity*

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1. Introduction

Customers' concerns about environmental issues have grown during last decades favouring a revision of their behaviours (Laroche *et al.*, 2001; Brody *et al.*, 2012). It favours higher eco-friendly alternatives for consumption with its subsequent purchase decisions (Paco and Rapose, 2009; Chen and Tung, 2014). As a consequence, a higher number of customers are looking for green products and are ready for paying more for them indeed (Kahn, 2007; Laroche *et al.*, 2001).

Among those concerns, climate change impacts are achieving a central position, and their mitigation is closely linked to energy consumption (Chen, 2016). Due to these circumstances, many consumers are interested in changing its consumption behaviour, supporting a development of human society not as focused on the consumption of natural resources and fossil fuels (Chen, 2016). In fact, in the climate change and energy scenario, the reduction of fossil fuels consumption and the increase of renewable energies are becoming two challenging tasks (Halder *et al.*, 2016). As a consequence, the social dynamics are contributing to the development of green energy (Alam *et al.*, 2014), since customers in the energy market are committed with environmental protection through green electricity (Wippermann *et al.*, 2008). The atmospheric consequences of carbon-fired power plants, worsening local air conditions due to smog, and global warming are factors that favours the development of a global green energy industry and its subsequent products (Rowlands *et al.*, 2002).

Since liberalization of electricity markets allows for an increasing competition and supplying alternatives, many customers do not only ask how much electricity is consumed and at what price, but also how electricity is generated (Rowlands et. al, 2002). The green electricity, understood as the electricity entirely generated from renewable energy sources with low impact on the environment (Kotchen and Moore, 2007; Lipp, 2000; Rowlands *et al.*, 2002; Salmela and Varho, 2006; Willstedt and Bürger, 2006), became a real alternative.

A number of studies have detected significantly positive associations between general environmental protection attitudes and willingness to switching to a green electricity supplier (Bang *et al.*, 2000; Rowlands *et al.*, 2003; Arkesteijn and Oerlemans, 2005; Hansla *et al.*, 2008; Bertoli, Busacca, Rozzi, 2011). Other authors suggested a direct relationship between trust and intention to switch (Garbarino and Johnson,1999) and found that the more users who trust a given supplier, the higher the adoption rate (Bhattacherjee, 2002; Arkesteijn and Oerlemans, 2005).

Despite the interest in trust as an important factor to explain switching behaviour there is no comprehensive approach to measure trust in green electricity suppliers. Some authors have assessed trust based on competence (Davies *et al.*, 2011; Park *et al.*, 2012), ability (Casaló *et al.*, 2010; Okazaki *et al.*, 2009), dependability (Delgado-Ballester *et al.*, 2003) and confidence in quality and reliability (Delgado-Ballester *et al.*, 2003; Garbarino, Johnson, 1999). Furthermore, some studies include an affective dimension conceptualised by factors such as sympathy (Hawes *et al.*, 1989; Swan and Nolan, 1985) and benevolence (Casaló *et al.*, 2010; Doney and Cannon, 1997; Park *et al.*, 2012). Additionally, some studies use the factors responsibility (Hawes *et al.*, 1989; Swan *et al.*, 1988), and integrity (Bhattacherjee, 2002; Davies *et al.*, 2011) to measure trust. This literature review revealed no comprehensive approach to capture the entire scope of the phenomenon of trust and no existing approach to measuring trust specifically in green electricity suppliers. Further, it revealed no existing research on trust in electricity suppliers. Although there are studies in industries such as fixed-line telephones and life insurance, both of which have similarities with the electricity industry, electricity markets differ from other industries because of product characteristics. For example, electricity is intangible, and consumers cannot verify product characteristics before, during or even after purchase. Therefore, consumers may be unsure about the credibility of suppliers and product characteristics. For this reason, this research intends to cover this gap developing an operationalization of trust that helps measuring trust and understanding consumers in a green market context, including its risks and benefits. In order to achieve this objective, an exploratory factor analysis is developed in Germany, including the development of a model and its subsequent confirmation in a second sample.

The paper is organized as follows, the first section deals with the different alternatives to measure trust as a factor influencing customer behaviours. The second section explains the methodology, including the sampling and the data collection and analysis. The third outlines the results obtained, and the last includes the implications and further research.

2. Theoretical background

Trust is a ubiquitous and multifaceted phenomenon, researched in academic disciplines like philosophy (Neumann, 2006), psychology (Deutsch, 1960; Rotter, 1967), sociology and economics (McKnight and Chervany, 1996).

The focus in those initial studies was on interpersonal relationships between buyers and sellers (Crosby *et al.*, 1990; Dwyer *et al.* 1987) and business-to-business relationships (Moorman *et al.*, 1993; 1992). But the emergence of relationship marketing literature embedded trust in a broader framework including business-to-consumers relationships (Anderson and Weitz, 1989; Ganesan, 1994, Morgan and Hunt, 1994). This stream of marketing emphasizes trust as a central element for long lasting relationships with profitable customers (Doney and Cannon, 1997; Morgan and Hunt, 1994). In words of Berry (1995, p. 242) trust is "the single most powerful relationship marketing tool available to a company".

Although the research on trust between firms and final customers relationships has been somewhat neglected in the past (Hennig-Thurau, 1998; Lee, Turban, 2001), in recent years there exists a high interest by academics (Kenning, 2008). This research field evaluates existing or potential relationship between buyer and seller, agreeing that consumers only choose vendors that enjoy a minimum degree of trust (Einwiller, 2003). Because of the omnipresence of trust, it is impossible to develop one general definition that is appropriate in all research contexts (Kenning and Blut, 2006. Accordingly, there is no consistent understanding of trust within academic disciplines, and it is defined in different ways.

In the context of green products, the term 'green trust' is used to describe the research context of trust in green electricity suppliers and is defined as "a willingness to depend on a product, service, or brand based on the belief or expectation resulting from its credibility, benevolence, and ability about its environmental performance" (Chen, 2010; p. 309)."

Overall, green trust is driven by the environmental friendliness of products and services that is recognised by consumers. In such cases, consumers perceive 'green characteristics' as expected, which increases perceived quality, lowers perceived risk and increases overall satisfaction (Chen, Chang, 2012). These findings comprise a core aspect of the trust construct and related antecedents for the green electricity market.

3. On the conceptualization of trust - results of a literature analysis

Since trust is understood as an attitude or expectation of the trustor towards the behaviour (Sirdeshmukh *et al.*, 2002) or specific characteristics (Doney and Cannon, 1997) of the trustee, many factors, antecedents and consequences can be considered, making it difficult to measure. The conceptualization of trust thus requires different models according to its research context (Kenning, Blut, 2006). In the literature on trust different approaches to measure trust can be found, some of them are single-factor, including single-item or multi-item scales, but the complexity of the construct favoured the apparition of multi-factor measurements.

Among the single-item approaches, Selnes (1998) operationalise trust in business relationships as a single item evaluated on a ten-point scale. Rampl *et al.*'s (2012) study on consumer trust in food retailers also using a single-item measurement, asking participants how much trust they have in a specific retailer. However this approach was not much used in literature because it can restrict the measurement of trust to very simple constructs (Hair Jr. *et al.*, 2006).

The multi-item approach was more used for analysing trust. Ranaweera and Prabhu (2003) and Crosby *et al.* (1990) focused on consumer trust in fixed-line telephone and life insurance industries. Crosby *et al.* (1990) interviewed 151 life insurance customers using nine items to measure trust, including reliability, trustworthiness, dishonesty and focus on customer interests. Ranaweera and Prabhu (2003) identified the influence of trust as a determinant of customer retention and word of mouth, evaluating trust of 461 fixed-line telephone users in their provider using a three-item scale following the commitment-trust theory of Morgan and Hunt (1994). Further studies with single-factor approaches are Anderson and Narus (1990), Mohr and Spekman (1994) and Dahlstrom and Nygaard (1995). Although these approaches achieve generally good reliability values, they do not accomplish sufficient degrees of external validity to represent trust in all facets.

Additional studies on single-factors approaches used multi-items scales but differentiating dimensions of the construct trust. Moorman *et al.* (1992; 1993) analysed the trust relationship between market research users and market research providers. They operationalised the trust construct with five items, those items are related to the dimensions of credibility and benevolence. Doney and Canon (1997) assessed trust of manufacturing companies in their supplier firms (eight items) and salespeople (seven items) as two independent constructs. They conceptualised trust with a single-factor approach that consists of the dimensions of credibility and benevolence, but those dimensions are so close that it is possible to asses them in one only dimension. Sirdeshmukh *et al.* (2002) examined the antecedents and consequences of consumer trust in retail and services. The authors differentiated between trust in frontline employees, who have direct contact with consumers, and trust in management policies and practices, discovering that trust is directly influenced by trustworthy behaviour and practices, distinguishing two constructs of trustworthiness (individual attitude) and trust (four items covering dependability, competence, integrity and responsiveness). Kikuchi-Uehara *et al.* (2016b) simplify the factors of trust on information sources in two dimensions, competence - perception of how institutions or individuals are knowledgeable and competent technically in a defined area (Kasperson *et al.*, 1992) - and trustworthiness - affective perceptions of those sources of information.

More recently, Chen's approaches towards green trust leverage single-factor, multiple-item measurement models of trust (Chen *et al.*, 2015). The items are similar in each paper and comprise reliability, dependability, trustworthiness as well as 'the product meets your expectations'. The 2010 and 2012 studies include a fifth item 'This product keeps promises and commitments for environmental protection'. The additional item emphasizes the environmental protection as a specific dimension of green trust.

Meanwhile Kikuchi-Uehara *et al.* (2016a, 2016b) intend to explain the role of trust regarding Ecolabels' information. To achieve their aim the authors include social values to understand the attitude towards the environmental information of products. Two types of factors are distinguished, the traditional view of trust encompasses scientific support and fairness in the consumers' evaluation of ecolabeling certification. The second, are factors related to social values such as the effectiveness in the environmental impact reduction and corporate consciousness on promoting environmental protection.

Nevertheless, conceptual research approaches emphasise trust is a multi-factor construct (Rempel *et al.*, 1985; Zaheer *et al.*, 1998). This approach achieves a stronger theoretical and methodological foundation with a higher level of validity because the research focus is on the conceptualisation and operationalisation of trust instead of explanation of relationships, antecedents and consequences of trust. It was formerly applied by Swan *et al.* (1988) and Hawes *et al.* (1989). More recent literature built on the previous traditional multi-factor scales are Bhattacherjee (2002), Delgado-Ballester *et al.* (2003), Okazaki *et al.* (2009), Davies *et al.* (2011) and Park *et al.* (2012), among others.

Bhattacherjee (2002) evaluated consumer trust in online firms using the dimensions of ability, benevolence and integrity to evaluate the trust construct. To generate items, the three factors were broken down further based on a literature analysis in the research context of electronic commerce and from an expert discussion/survey. Delgado-Ballester *et al.* (2003) carried out a comprehensive

study to develop and validate a model to measure consumer trust in brands conceptualising trust as a construct with two factors: reliability and intention. This factor consists of the aspects of altruism, benevolence, honesty, dependability and fairness. Delgado-Ballester *et al.* (2003) assigned to the factor of reliability items such as altruism, benevolence, honesty, dependability and fairness. Meanwhile Okazaki *et al.* (2009) use three factors, ability, benevolence and integrity to analyse consumer privacy concerns in the Japanese mobile phone market. Casaló *et al.* (2010; 2011) measured trust in online communities as well as online retailers based on the three factors honesty, benevolence and ability. The three dimensions of trust were based on nine items, three per factor. Davies *et al.* (2011) analyse trust in franchise relationships to understand the role of non-compliant behaviour in such relations. Trust was based on two factors, integrity and competence (three items each), while satisfaction and conflict represent antecedents of trust and compliance a consequence of trust. Finally, Park *et al.* (2012) built on a multi-dimensional model of trust in online retailers based on three dimensions: competence, benevolence and integrity. Competence was based on four items, benevolence on three items and integrity again on four items.

The previous review of literature revealed no comprehensive approach to capture the entire scope of the phenomena of trust and, particularly, for such specific context as green energy; no study analyses trust in electricity markets indeed. As the electricity is intangible and customers cannot verify the characteristics of the product before, during or after the purchase, it is necessary to develop a specific model to measure trust in green electricity markets.

4. Context of the study and methodology

We selected the case of German market because, from an international point of view, Germany can be seen as one of the pioneering countries in the development of green electricity. In 2017 already one third of the energy produced in Germany came from renewable sources. This corresponds to an amount of 218 billion kWh (BDEW 2018b). As shown in table 1 the share of energy from renewable source has grown continuously since 1991.

Tab 1: Gross electricity production in Germany in billion kWh

	1991	**1995**	**2000**	**2005**	**2010**	**2015**	**2017**
Overall electricity production	540	537	577	623	633	648	655
Production of renewable sources	17	25	38	63	105	189	218
Percentage share	3,1%	4,7%	6,6%	10,1%	16,6%	29,2%	33,3%

Sources: BDEW, 2018a; BDEW, 2018b; our elaboration

This increase is a consequence of new regulations implemented by the government (Wüstenhagen and Bilharz, 2006) coupled with consumers' awareness in environmental issues (Rowlands *et al.*, 2002). Suppliers of green electricity products can be divided into the following three groups (Sunderer, 2006):

- New nationwide suppliers, independent from the four well-established and vertically integrated companies. These suppliers have not been previously involved in electricity generation and exclusively offer green electricity products (Rohracher, 2009; Wüstenhagen and Bilharz, 2006); they are not connected with nuclear or coal-fired power stations, their products are 100% green electricity (Leprich, 2008; Sunderer, 2006). In 2011, the four largest companies accounted about 900,000 customers.
- Electricity groups (vertically integrated companies) with their own green electricity brands. This category includes large nationwide green electricity suppliers participating with large supraregional (vertically integrated) suppliers.
- Local green electricity from regional or municipal suppliers (Sunderer, 2006).

Summarizing, the green electricity market has some differential characteristics in its dynamics

due to its recent-born status; particularly, the emergence of new green electricity products, mainly from small newly established providers, and the lack of reputed brands with a long-term history in the electricity market.

5. Empirical analysis

The development of a measurement model for the theoretical construct of consumer trust can be achieved by surveying a set of relevant perceived characteristics of a company (Homburg and Giering, 1996). This process takes several steps, the first is the generation of a list of items that can measure trust.

5.1 Generation of item list

In order to extract and identify previously used items from the existing literature on consumer trust in (green) electricity providers, a list of items containing non-context specific (i.e. non-industry, no country, non-time context specific) was created. This step followed the approach suggested for David and Han (2004), searching for public academic articles in comprehensive academic databases, including a comprehensive key word search (consumer and trust*). To eliminate irrelevant articles, additional keywords were used. The selected articles were required to contain at least one of 12 additional keywords in the title or abstract These keywords are synonyms of trust and keywords specific to the research context of buyer-seller relationships and consumer behaviour as well as relevant keywords found in existing models of trust. From the database Business Source Elite, a total of 600 papers were collected and 105 analysed in depth (see the table of the appendix A for the detailed analysis). The final list of selected articles was obtained by selecting titles and abstract containing also empirical content: data, empirical, test, statistical, finding*, result*, evidence.

The first list, coming from existing literature, comprised 42 measurable characteristics of electricity providers associated with the notion of trust. The items determined through the previous literature review were expanded by adding synonyms for the terms. This allowed controlling for personality- and context-related differences so understanding and daily use of the adjectives was the focus. Following this procedure, the existing list was expanded by 69 synonyms, resulting in 111 items. The third phase was taken to achieve a deeper empirical understanding of the trust construct in the context of green electricity. Qualitative semi-structured interviews were conducted with executive MBA students (n=31) between October and November 2012. All interviewees had signed an electricity contract for their rented or owned flat within the previous five years. A total of 39 additional items resulted from this analysis. The list was expanded to a total of 150 items and it became the basis for the creation of a new model to measure trust in electricity markets.

5.2 Survey to reduce item list

The second step was a survey to reduce the initial number of items and removing items with low understandability and relevance (Homburg and Giering, 1996). It helped to delete items that were overly specific or personal or not used by a broad set of electricity consumers and to better identify adjectives regarding the construct of trust to derive the most relevant items for the final model. This step was important to avoid inappropriate items that would limit further analysis (Homburg and Giering, 1996) and because the list of items should be manageable.

The survey was conducted through additional interviews with 16 electricity consumers in a convenience sample. The number of interviews was significantly higher than pre-test participants in similar studies (Bhattacherjee, 2002). These interviews were conducted in person or by phone between February and April 2013. The interviewees were between 26 and 60 years old with an average of 35.6 years, and 44% were male and 56% were female.

The interviews focused on the participants' personal understanding and characterisation of trust in electricity suppliers. First, participants were asked to describe characteristics of electricity suppliers they trust, which were compared to characteristics on the initial list; all adjectives suggested by participants were already in the list, indicating the comprehensiveness of the initial 150-item list. In the second part of the interviews, the participants were asked to evaluate all 150 items in terms of (1) how well the items fit with everyday language use and (2) if the item adequately characterised their trust in electricity suppliers using a five-point Likert scale (1= totally disagree, 5= totally agree). For both criteria were calculated the means of all items. Subsequently, items with a mean equal to or lower than 3.0 for both criteria were eliminated, leaving 58 items.

5.3 Data collection and sample

An empirical online survey was conducted between the end of May and the beginning of October 2013[1]. The questionnaire had two main parts. First, a short introduction outlining the study and questions related to personal data (demographics) and about the electricity supplier (i.e., name, type of tariff, if and how often the respondents switched suppliers). Second, questions to evaluate their electricity supplier according to the 58 characteristics from the preliminary analysis, using a five-point Likert scale (1= totally disagree, 5= totally agree). A total of 353 respondents participated in the survey, but due to missing values in 49 questionnaires[2], the final sample was 304 participants. Table 2 reflects the description of the sample, including its comparison with German population.

According to Hair Jr. (2006), a sample must have more observations than variables; the minimum of observations should be more than 50 and preferably more than 100, and 10 observations for each variable are needed for analysis up to a total sample size of 300. Hence, the sample size of this study including 304 respondents is adequate for the exploratory factoranalysis.

Tab. 2: Samples descriptive analysis

Sample 1		**Survey**		**German population**
		Frequency	%	%
Gender	Male	175	57.6	49.1*
	Female	129	42.4	50.9*
Age	under 30	72	23.7	30.6*
	30-49	180	59.2	28.5*
	50-64	46	15.1	20.4*
	over 64	4	1.3	20.6*
Electricity supplier	General	275	90.5	88.3
	Pure green	29	9.5	11.7 **
Sample 2		**Town**		**German population**
		Frequency	%	%
Gender	Male		51	49.1***
	Female		49	50.9***
Age	under 30		29.1	30.6***
	30-49		28.5	28.5***
	50-64		20.4	20.4***
	over 64		20.6	20.6***
Electricity supplier	General	79	93.0	88.3
	Pure green	6	7.0	11.7**

Sources: * Destatis (2013); ** Bundesnetzagentur (2013); *** Statistisches Landesamt Baden-Württemberg (2014), our elaboration

[1] As the response rate was low during summer months (July and August), the period for the online survey was extended. Throughout the long data collection period a constant intake of responses was recorded, showing no indication of multiple response waves.

[2] Only surveys with a complete evaluation of all 58 items were considered for subsequent analysis. The high number of missing values seems to stem from the rather large number of items to be evaluated. That is, missing values do not emerge from not evaluating individual items, but from participants cancelling the survey towards the end.

After examining the developed model to measure consumer trust in (green) electricity suppliers, the next research step assessed whether the model can deliver consistent results in a different time interval. Therefore, a written survey was administered in a small town in Germany between October and December 2013. The questionnaire was part of a larger energy study of a University of the region. The questions were designed to collect data about respondents' electricity suppliers (e.g., name, type of tariff, if and how often the respondents had switched suppliers) and the evaluation of these electricity suppliers based on the 15 characteristics resulting from previous analysis. Questions, data collection and analysis proceedings were adapted from the initial online survey. During the survey period, 165 respondents participated. Again, there was a significant amount of missing values in 80 questionnaires, so the final sample included 85 participants whose characteristics are shown in table 2.

5.4Quantitative analysis

The analysis applied is exploratory factor analysis run through SPSS 20.0 and SPSS AMOS 22. The first step included the analysis of the dataset applying test for normality through KMO and Bartlett's test. Next, the method of factor extraction was used to determine the number of factors through principal component analysis, and the varimax rotation was carried out to interpret factors, due to multidimensional nature of trust and the identification of independent factors of trust in previous models. Finally, first and second generations methods were used to evaluate the reliability and validity of the model, including coefficient alpha and maximum likelihood estimation and standardised regression weighs calculated.

6. Results

The application of KMO showed good results with .954 and .854 respectively in the first and second sample. Bartlett's test offered good values with a significance level of .000 in both samples. The sample is thus appropriate to develop a factor analysis.

6.1 Derivation of underlying factors

The principal component analysis showed that nine factors had eigenvalues higher than one (table 3), with a total explained variance of 71.872 percent. This high number of factors does not meet the requirements for a compact, manageable model.

Tab. 3: Total Variance Explained (Extraction Method: Principal Component Analysis)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% Variance	Cumulative %	Total	% Variance	Cumulative%
1	23.865	41.147	41.147	23.865	41.147	41.147
2	5.295	9.129	50.276	5.295	9.129	50.276
3	2.675	4.612	54.888	2.675	4.612	54.888
4	2.169	3.739	58.627	2.169	3.739	58.627
5	2.045	3.526	62.153	2.045	3.526	62.153
6	1.774	3.058	65.211	1.774	3.058	65.211
7	1.568	2.703	67.914	1.568	2.703	67.914
8	1.194	2.059	69.973	1.194	2.059	69.973
9	1.101	1.899	71.872	1.101	1.899	71.872
…	…	…	…			
58	.070	.120	100.000			

Source: our elaboration

Evaluating the communalities after extraction, the average is .719 while most (except for five items) are >.6 (see Table 4). This indicates a high proportion of shared variance and, thus, a well-suited amount of variance that is explained by the retained factors.

Tab. 4: Communalities (Extraction Method: Principal Component Analysis)

	Extraction		Extraction
competent	.704	credible	.766
consistent	.582	serious	.752
qualified	.727	honest	.787
able	.742	fair	.721
specialised	.597	sincere	.775
knowledgeable	.751	accurate	.689
convincing	.686	transparent	.630
professional	.726	trustworthy	.812
justly	.662	confidential	.718
experienced	.750	reliable	.795
efficient	.687	equitable	.686
expert	.762	modern	.615
wellrespected	.713	dependable	.783
meetsexpectations	.542	canbecountedon	.778
flexible	.663	economicstable	.539
innovative	.696	recommendable	.757
renewable	.704	constant	.686
green	.820	avaliable	.681
sustainable	.852	proven	.715
evironmentallysound	.780	customerfriendly	.774
ecologicallyworthwhile	.818	popular	.616
qualityconcious	.620	well-known	.700
safe	.625	accommodating	.720
environmentallyaware	.814	cooperative	.734
environmentallyresponsible	.805	friendly	.715
responsible	.741	serviceoriented	.813
local	.807	approachable	.809
national	.442	accesible	.770
regional	.719	customeroriented	.808

Source: our elaboration

6.2 Factor interpretation

Since this study includes many items, strict criteria were followed for item selection. To achieve lower complexity and a well-designed structure, Hair Jr. *et al.*'s (2006) suggestions were applied. All items with values lower than .7 were eliminated, reducing the list to 24 items. Furthermore, the items 'local', 'regional' and 'national' were deleted. Particularly, in the case of 'national' was deleted because the factor loading is lower than .7. In the case of local and regional the interpretation of results were not considered because they do not correctly fit within a component attending to the interpretation of results. Based on initial component analysis, these three items were grouped together as one factor. The item 'national' had a negative factor loading of -.534. Although the items, 'local' and 'regional', had relatively high factor loadings (regional=.813, local=.875), they do not provide added value for measuring trust. After these reductions, 21 items remained (Table 5). With these 21 items an exploratory factor analysis was carried out again resulting in four factors with total explained variance of 75.32 percent.

Tab. 5: Rotated Factor Matrix (21 items)

	Factor			
	1	**2**	**3**	**4**
Green	.893			
Sustainable	.887			
Ecologically worthwhile	.879			
Environmentally responsible	.849			
Environmentally sound	.848			
Environmentally aware	.828			
Renewable	.821			
Honest		.826		
Sincere		.795		
Trustworthy		.793		
Reliable		.792		
Can be counted on		.552		.486
Dependable		.526		.515
Approachable			.868	
Accessible			.855	
Customer oriented			.766	
Service oriented			.753	
Experienced				.786
Well-known				.677
Expert				.650
Knowledgeable				.640

Source: our elaboration. Extraction: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Rotation converged in six iterations.

The rotated factor solution provided meaningful factors. Explained total variance was equally distributed, and there was no strong emphasis on any single factor.

Tab. 6: Quality criteria of factors (Sample 1; n=304)

	Total variance %	**Coefficient alpha**
Factor 1	27.430	.955
Factor 2	19.392	.913
Factor 3	15.651	.922
Factor 4	12.845	.753

Source: our elaboration

The factor interpretation includes the estimation of the factor matrix, choice of rotation method and factor interpretation and respecification (Hair Jr. *et al.*, 2006). Each respecification provides new results for items that let researchers adjust the items achieve a more consistent model. The resulting factors were evaluated individually. Firstly, the items ‘can be counted on’ and ‘dependable’ were deleted because of their low loadings on factor two and high cross-loadings with factor four (.486 and .515). The rotated factor matrix resulted in four factors.

The first factor is characterised by the items ‘green’ (.893), ‘sustainable’ (.887), ‘ecological worthwhile’ (.879), ‘environmentally responsible’ (.849), ‘environmentally sound’ (.848), ‘environmentally aware’ (.828) and ‘renewable’ (.821). Each item showed factor loadings above the expected threshold of .7, and the explained total variance was 27.430 percent. Swan *et al.* (1988) stated that ‘responsibility’ is an element of trust that protects the interests of other people. In the context of green electricity, the interest of consumers purchasing green electricity is to obtain electricity from pure green electricity sources. Therefore, this factor contains items referring to production types that are integrated into the factor ‘responsibility’.

The items ‘honest’ (.826), ‘sincere’ (.795), ‘trustworthy’ (.793) and ‘reliable’ (.792) loaded on the second factor, which explained 19.392 percent of total variance. These items represent the degree to which consumers recognise that suppliers stand by their offers and statements and fulfil promises to consumers and can thus be summarised in a factor referred to as ‘authenticity’. Authenticity can be defined as granting an accurate representation of facts or reliability (The Free Dictionary, 2014). Further, in modern consumer culture, authenticity is often characterised as trustworthiness (Gustafsson, 2006).

The third factor explained 15.651 percent of total variance and was indicated by the items ‘approachable’ (.868), ‘accessible’ (.855), ‘customer oriented’ (.766) and ‘service oriented’ (.753). This factor is referred to as ‘openness’. The existing literature on trust does not include this factor. A possible explanation for this exclusion may be that this aspect acquired only minor significance in research on business-to-business relationships. As the results of the exploratory factor analysis show, ‘openness’ is clearly a factor of trust. People or organisations that are inaccessible to others provide no chance to test them and thus cannot achieve trust (Luhmann, 1989). On this basis, the factor of ‘openness’ can be used to conceptualise consumer trust in green electricity suppliers (as an organisation).

Analysis of the fourth factor showed that the item ‘experienced’ (.786) exceeded the threshold of .7 for factor loadings (Hair Jr. *et al.*, 2006). According to Hair *et al.* (2006), the items ‘well-known’ (.677), ‘expert’ (.650) and ‘knowledgeable’ (.640) achieve factor loadings with practical significance at values above .5. This factor explains 12.845 percent of total variance, which is a sufficient result. All items refer to the expertise of the supplier and thus the factor is referred to as ‘competence’. Results from exploratory factor analysis are also supported by the identification during the literature analysis of ‘competence’ as a factor of consumer trust (Swan *et al.*, 1988).

6.3 Measurement model quality

In the study, all four factors had a coefficient alpha higher than .7 (table 7). Factors one to three show coefficients higher than .9 while factor four (‘competence’) showed a value of .753. Once analysed that factor, the item ‘well-known’ does not fit thematically with the other items of the factor. The items, except ‘well-known’, deal with the competence or ability of the supplier. It is possible that a supplier is well-known not based on competence but because of negative actions. This was confirmed by the corrected item to total analysis. Deleting this item results in an increase of the coefficient alpha from of .858.

Comparing the number of items in each factor, the first factor is an outlier with seven items. Moreover, the items ‘environmentally…’ are semantically similar, ‘renewable’ is regarded as a synonym for ‘green’ as well as ‘sustainable’. A reduction of items was used to address these aspects. As a guideline, a similar number of items for all factors was intended. Thus, only the four items with the highest loadings were selected for further analysis, namely ‘green’, ‘sustainable’, ‘ecologically worthwhile’ and ‘environmentally responsible’.

After these adjustments, exploratory factor analysis was carried out for the newly revised list with 15 remaining items. This analysis resulted in a manageable measurement model for trust with four factors. The explained total variance was 82.278% (23.219% for factor 1; 21.688% for factor 2; 21.292% for factor 3; 16,080% for factor 4).

To ensure convergent and discriminant validity, an exploratory factor analysis was conducted for each factor. The extracted factor should explain a minimum of 50 percent of the variance of the item, while singular factor loading should be higher than .4 (Homburg, Giering, 1996); as shown in table 6, explained variance of each factor is higher than the required minimum.

Tab. 7: Internal consistency of factors (sample 1, n=304)

Factor	Item	Corrected item-total correlation	Factor loading (≥.4)	Coefficient alpha (≥.7)	Explained total variance (≥50%)
Responsibility	Green	.834	.894	.935	83.717
	Sustainable	.847	.888		
	Ecologically Worthwhile	.826	.881		
	Environmentally Responsible	.879	.851		
Authenticity	Honest	.830	.827	.929	82.402
	Sincere	.916	.812		
	Reliable	.904	.807		
	Trustworthy	.900	.806		
Openness	Approachable	.842	.882	.922	81.096
	Accessible	.800	.872		
	Customer oriented	.832	.773		
	Service oriented	.805	.750		
Competence	Experienced	.686	.844	.858	77.956
	Expert	.784	.807		
	Knowledgeable	.726	.778		

Source: our elaboration

6.4 Overall model fit

Goodness of fit measures indicate a good model fit based on CMIN/df=1.635, CFI=.987 and RMSEA=.034. The measure values in Table 8 demonstrate appropriate indicator and factor loadings as well as factor reliabilities that exceed the threshold of .6. The AVE for the latent trust construct has values exceeding .5 in all cases; convergent validity can be assumed (Hair Jr. *et al.*, 2006).

Tab. 8: Convergent validity (Sample 1)

Factor	Item	FL (≥ .4)	IR (≥ .4)	FR (≥ .6)	AVE (≥ .5)
Responsibility	Environmentally Responsible	.861	.741	.935	.783
	Ecologically Worthwhile	.874	.764		
	Sustainable	.926	.858		
	Green	.878	.770		
Authenticity	Trustworthy	.912	.831	.928	.764
	Reliable	.895	.802		
	Sincere	.833	.694		
	Honest	.855	.732		
Openness	Service oriented	.876	.767	.921	.745
	Customer oriented	.897	.805		
	Accessible	.822	.675		
	Approachable	.857	.734		
Competence	Knowledgeable	.821	.802	.861	.688
	Expert	.895	.802		
	Experienced	.740	.548		

Source: our elaboration

Discriminant validity was assessed by the Fornell-Larcker criterion (Fornell, Larcker, 1981; Ulaga, Eggert, 2005). Table 9 shows an adequate level of discriminant validity demonstrating the independence among the four constructs (Hair Jr. *et al.*, 2010).

Tab. 9: Discriminant Validity (Sample 1; n=304)

	Openness	Responsibility	Authenticity	Competence
Openness	**.745**			
Responsibility	.467	**.783**		
Authenticity	.672	.537	**.764**	
Competence	.635	.307	.637	**.688**

Source: our elaboration
Note: Bold numbers on the diagonal exhibit the AVE. The numbers below the diagonals reveal the squared correlation of the two constructs.

6.5 Assessment of the measurement model - Control sample

Once developed the model to measure consumer trust in (green) electricity suppliers, the next step is assessing the model to study its consistency in different time intervals. The data showed a good consistency as explained in the analysis of data set. The exploratory factor analysis deployed followed the same procedures than in the main sample. Based on eigenvalues higher than one, the analysis resulted in four factors with a total explained variance of 84.98 percent (table 10).

Tab. 10: Total Variance Explained (sample 2)

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	Variance %	Cumulative	Total	Variance %	Cumulative	Total	Variance %	Cumulative
1	7.405	49.364	49.364	7.405	49.364	49.364	3.533	23.553	23.553
2	2.709	18.063	67.427	2.709	18.063	67.427	3.392	22.611	46.165
3	1.538	10.254	77.681	1.538	10.254	77.681	2.930	19.535	65.700
4	1.096	7.303	84.985	1.096	7.303	84.985	2.893	19.285	84.985

Source: our elaboration

The factors and related items confirm the model of the first study. Although the percentage of explained variance of each factor differs and the items show different factor loadings, the overall structure of the model can be confirmed. The factor ‘authenticity’ consists of the items ‘trustworthy’, ‘honest’, ‘reliable’ and ‘sincere’. The factor ‘responsibility’ consists of the items ‘green’, ‘ecologically worthwhile’, ‘environmentally responsible’ and ‘sustainable’. The factor ‘openness’ consists of the items ‘service oriented’, ‘approachable’, ‘accessible’ and ‘customer oriented’. The factor ‘competence’ consists of the items ‘expert’, ‘experienced’ and ‘knowledgeable’. The analysis for internal consistency showed appropriate values, and also convergent and discriminant validity can be assumed. Table 11, 12 and 13 summarises the results of the internal consistency analysis.

Tab. 11: Internal consistency of factors (sample 2, n=85)

Factor	**Item**	**Corrected item-total correlation**	**Factor loading (≥.4)**	**Coefficient alpha (≥.7)**	**Total Explained Variance (≥50%)**
Responsibility	Green	.884	.920	.920	80.922
	Ecologically Worthwhile	.861	.911		
	Environmentally Responsible	.845	.892		
	Sustainable	.683	.748		
Authenticity	Trustworthy	.915	.904	.955	88.185
	Honest	.905	.888		
	Reliable	.906	.854		
	Sincere	.838	.804		
Openness	Service oriented	.806	.856	.895	76.208
	Approachable	.780	.837		
	Accessible	.741	.738		
	Customer oriented	.749	.667		
Competence	Expert	.940	.925	.950	91.221
	Experienced	.885	.895		
	Knowledgeable	.867	.846		

Source: our elaboration

The evaluation of measurement quality also provided acceptable results. Goodness of fit measures of the confirmatory factor analysis (i.e., CMIN/df = 1.662, CFI = .958 as well as RMSEA= .089) indicated adequate model fit. Factor loadings and AVE exceed the minimum thresholds and validity can be verified (table 12).

Tab. 12: Convergent validity (sample 2)

Factor	Item	FL (≥ .4)	IR (≥ .4)	FR (≥ .6)	AVE (≥ .5)
Responsibility	Green	.887	.787	.925	.756
	Ecologically Worthwhile	.964	.930		
	Environmentally Responsible	.900	.810		
	Sustainable	.707	.499		
Authenticity	Trustworthy	.972	.946	.961	.861
	Honest	.918	.843		
	Reliable	.929	.863		
	Sincere	.891	.793		
Openness	Service oriented	.849	.721	.897	.684
	Approachable	.832	.692		
	Accessible	.797	.635		
	Customer oriented	.830	.689		
Competence	Expert	.981	.963	.954	.875
	Experienced	.925	.855		
	Knowledgeable	.898	.806		

Source: our elaboration

Table 13 shows that the lowest AVE exceeds the highest squared correlation between a pair of constructs; the postulated coherences between the factors and the trust construct are supported.

Tab. 13: Discriminant Validity (Sample 2)

	Openness	Responsibility	Authenticity	Competence
Openness	**.684**			
Responsibility	.575	**.861**		
Authenticity	.329	.448	**.756**	
Competence	.632	.420	.213	**.875**

Source: our elaboration
Note: Bold numbers on the diagonal exhibit the AVE. The numbers below the diagonals reveal the squared correlation of the two constructs.

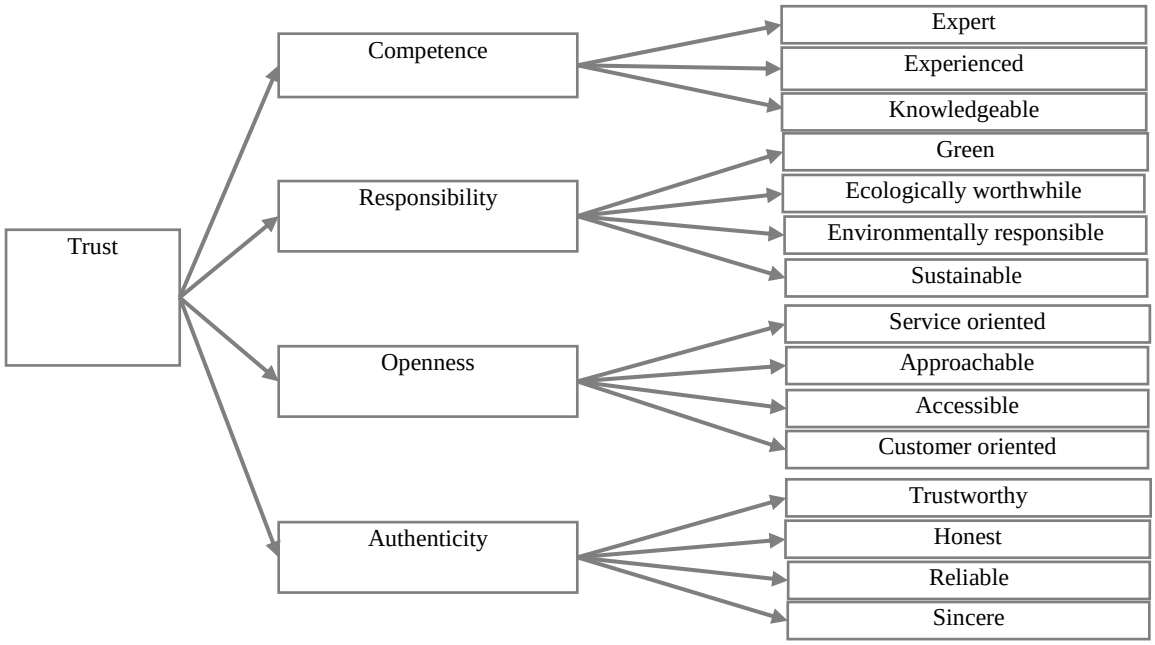
7. Discussion and conclusion

Based on the results, the final measurement model consists of four factors: competence, responsibility, openness, and authenticity (figure 1). Competence describes the consumers' perception of a supplier ability to deliver the desired performance. The factor 'responsibility' indicates whether the supplier intends to deliver an environmentally-beneficial product of the declared quality and intends to keep its environmental promises. The third factor 'openness' describes consumers' evaluation of whether the electricity supplier provides an open information exchange. Authenticity reflects the way a supplier keeps its promises and delivers on its offers. In summary, trust in green electricity providers represents the attitude of an electricity consumer towards its provider, considering that this provider acts in an environmentally responsible manner by competently and sustainably supplying electricity that (based on its origin) can be considered 'green' (i.e., ecologically worthwhile and responsible) while engaging with consumers openly and authentically through its marketing activities.

From a theoretical perspective, the proposed model follows the multiple-factor approach to measure trust, due to the broad nature of the construct suggested in literature. The holistic approach achieved in the measurement model helps to consider different realities of a so complex construct as trust on the basis of a solid theoretical revision. Indeed, the factors' denominations were developed in line with previous theoretical contributions in order to facilitate its understanding (Swan *et al.*, 1988; Gustafsson, 2006). Additionally, it helps to address shortcomings in previous academic

discussions about the measurement of trust, specifically in the context of green products or service consumption. It shows an evolution in comparison to Chen and Chang (2012) who operationalise green trust as a single-factor, multi-item construct. The factor responsibility represents the environmental performance that plays a key role in green trust (Chen, 2010). The model proposed complete both Chen (2010) and Chen and Chang (2012) measurement of trust with three additional factors making the construct more precise. Moreover, the authors do not consider other factors identified in literature because of the specificities of green consumers (e.g. benevolence, dependability and integrity), enclosed indirectly in the factors identified.

Fig. 1. The model: Factors and items of green trust



Source: our elaboration

Among managerial implications, any study that can help better comprehend what influence consumers' trust has is important; particularly, in a growing and complex market as green industries, where the influence of intangible factors is basic. Among the levers identified to build green consumer trust, authenticity implies the development of a clear and documented communication between company and consumer; it is important to fulfil promises. The source of the provider and the environmental impact are two main issues the consumer is highly interested in that can be attended through a fluent documentation justifying the supplier practices. The responsibility reflects the green features of trust in such a specific market as electricity markets; customers expect suppliers offer environmentally sustainable and ecologically sound products as well as developing actions to deliver positive environmental outcomes. It should be core in communication and marketing efforts to reinforce its impact on environment. The openness plays a major role in trust because it includes explaining the origin of electricity and the investment in facilities to foster this clean energy. It implies assuming service and customer orientation in the management of relationships through different channels, sales and after-sales staff, online media, customer events, and any type of communication selected. Finally, the competence is critical in order to customers rely on suppliers and their ability to perform their activity; the technical-based information, the technical knowledge of sales service and any dialogue sponsored by suppliers with experts in the field can help demonstrate this expertise. Finally, in order to facilitate consumers' recognition, the development of labels that help to signal good practice with environment warranting the achievement of a minimum standard (Bürger, 2007). It would facilitate the implementation and understanding of consumers without fraud or providing misleading customer information (Rohracher, 2009; Wüstenhagen and Bilharz, 2006).

Among the main limitations of the study, first, it is necessary to mention that trust can be very specific in different market contexts. This research it is applied in the electricity market, so, it is particularly applicable to similar markets, despite some factors can be universal. Second, the data collection is located in Germany, although it is a developed economy and has a strong presence of ecological behaviour, it should be taken under account because cultural norms, values and perceptions influence customer behaviours (Solomon, 2011). Third, although the research includes two samples in different moments, the cross-sectional approach has some limitations that could be minimized through a longitudinal analysis to evaluate the evolution during time.

Further research can consider the validation of the measurement model in different industries and countries to assess its appropriateness in different contexts. Additionally, it would be worthy to apply the construct in a higher theoretical model that help study the influence of trust in relation to different antecedents, in their impact on loyalty or switching behaviour, important consequences associated in literature to trust. Maybe the comparison of the behaviour between green and regular consumers can stablish some basis that let differentiate the consumption patterns and decisions processes.

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Appendix A. **Table of items selection**

Item	Elimination criteria		Item	Elimination criteria		Item	Elimination criteria	
	Everyday Characterises language trust			Everyday Characterises language trust			Everyday language	Characterises trust
well-tried	X	3.40	sound	4.20	X	**well respected**	**3.27**	**3.27**
interested in my welfare	X	X	harmonic	4.20	X	shows consideration	4.33	X
approachable	**4.20**	**3.13**	individual	4.40	X	**knowledgeable**	**3.20**	**3.60**
respectable	4.27	X	**innovative**	**4.33**	**3.67**	clean	4.60	X
attractive	4.60	X	integer	X	X	unselfish	3.73	X
open-minded	4.27	X	keeps best interests in mind	X	X	**serious**	**4.27**	**3.87**
self-sacrificing	X	X	interested	4.73	X	**service oriented**	**4.20**	**4.20**
straight	3.33	X	companionable	3.13	X	**safe**	**4.80**	**4.07**
sincere	**3.73**	**3.20**	municipal	X	3.40	solidary	3.07	X
authentic	3.87	X	communicating well	3.93	X	solid	3.33	X
well-known	**4.53**	**3.87**	communicative	4.33	X	diligent	4.33	X
popular	**4.67**	**3.33**	**competent**	**4.73**	**4.33**	**specialised**	**4.67**	**3.53**
consistent	**3.93**	**3.80**	**constant**	**4.60**	**3.73**	state owned	4.20	X
proven	**4.33**	**4.20**	**cooperative**	**4.67**	**3.33**	constant	3.73	X
direct	4.80	X	**accurate**	**4.53**	**3.60**	likeable	4.73	X
discrete	4.07	X	**customer friendly**	**4.20**	**4.13**	expensive	4.80	X
genuine	4.60	X	**customer oriented**	**4.40**	**4.07**	**transparent**	**4.53**	**3.40**
honourable	X	X	**efficient**	**4.67**	**4.00**	abiding	4.13	X
honest	**4.80**	**3.20**	liberal	X	X	moral	X	X
dignified	X	X	likeable	4.07	X	**convincing**	**4.53**	**3.33**
simple	4.60	X	**local**	**3.93**	**3.13**	**environmentally aware**	**4.33**	**3.87**
empathic	3.07	X	loyal	3.93	X	**environmental responsible**	**4.60**	**3.60**
established	3.47	X	powerful	2.07	X	autonomous	4.40	X
justly	**4.20**	**3.20**	similar to me	3.20	X	not corrupt	3.47	X
recommendable	**4.40**	**3.73**	sympathetic	4.07	X	unconstrained	3.60	X
accommodating	**3.73**	**3.13**	mid-sized	3.67	X	hassle-free	4.53	X
suits me	3.13	X	**modern**	**4.67**	**3.27**	supportive	4.27	X
experienced	**4.20**	**3.73**	motivated	4.87	X	unbiased	3.00	X
renewable	**3.87**	**3.93**	**sustainable**	**4.33**	**4.47**	**responsible**	**4.67**	**3.87**
serious	3.93	X	related	3.33	X	connected	3.87	X
proven	3.13	X	**national**	**3.27**	**3.33**	**available**	**4.27**	**3.53**
accessible	**4.33**	**3.67**	naturally	4.67	X	**can be counted on**	**4.20**	**4.33**
meets expectations	**4.13**	**3.13**	beneficial	4.53	X	reticent	3.87	X
expert. skilled	**3.73**	**3.40**	objective	4.33	X	understanding	4.40	X
able	**4.20**	**3.67**	open	4.67	X	**confidential**	**3.73**	**3.27**
fair	**4.80**	**3.93**	public	4.40	X	confiding	X	X
familial	4.27	X	**environmentally sound**	**3.20**	**3.93**	**trustworthy**	**4.07**	**3.40**
flexible	**4.80**	**3.40**	shows ecological engagement	X	3.80	**reliable**	**4.47**	**3.53**
friendly	**4.67**	**3.33**	**ecologically worthwhile**	**3.73**	**3.93**	familiar	4.20	X
amicable	3.67	X	personal	4.53	X	truthful	X	X
caring	3.53	X	dutiful	4.13	X	truly	X	X
forthright	X	X	private	4.73	X	warm	4.53	X
straightforward	3.33	X	productive	3.47	X	**economically stable**	**3.80**	**3.53**
equitable	**4.47**	**3.27**	**professional**	**4.27**	**3.87**	nameable	X	X
faithful	4.13	X	profit oriented	3.47	X	benevolent	3.60	X
credible	**4.33**	**3.87**	**qualified**	**4.53**	**3.73**	congruent goals	X	X
consistent	X	X	**quality conscious**	**4.33**	**3.93**	satisfied	4.80	X
big	4.33	X	responsive	3.13	X	approachable	4.07	X
generous	4.33	X	candid	X	X	**dependable**	**4.87**	**4.27**
green	**4.33**	**3.27**	**regional**	**4.27**	**3.40**	free	3.87	X

Last and least: When hotel guests don't care about environmental policies♦

GRAZIANO ABRATE* REBECCA PERA• SARAH QUINTON♠

Abstract

Objectives. *The study tests whether guests' perceptions of the environmental policies put in place by the hotel influences guests' evaluation of their overall experience.*

Methodology. *The empirical analysis uses a dataset of 52,764 reviews from a hotel chain's internal platform, which specifically requests for a guest evaluation of the environmental policies. The sample includes data from 105 European hotels in 2017-2018. A semantic content analysis on almost 100,000 observations from the chain's internal and from open peer-to-peer platforms complements the quantitative study.*

Findings. *Findings suggest that hotel guests, when evaluating the overall experience, don't take into account their own evaluation on the environmental policy.*

Research limits. *The study adopts a single case-study approach, which does not allow for the generalizability of its findings. The study cannot disentangle the motivation of the results (e.g. limited care about the environment or inability to make the assessment). Moreover, the research does not consider the eventual impact on consumers' purchase intention or willingness to pay.*

Practical implications. *Hotel managers can improve their environmental communication strategies to enhance perceived relevance of it. Open peer-to-peer platforms could promote environmental discussion by adding a specific review item. More generally, environmental regulation remains crucial, since results suggest caution in relying on consumer-driven greening strategies.*

Originality of the study. *To our knowledge, this is the first study providing a specific assessment of the effect of environmental policies on hotel guests' overall satisfaction. Previous studies largely suggest that "greening" a hotel appears to be inevitable to meet hospitality consumers' increasing green needs, but the analysis of consumers' evaluations contradicts this view.*

Key words: *Environmental policies; consumer experience; mixed-method analysis; hospitality industry*

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1. Introduction

Companies are facing increasing pressure to both maintain profitability and behave in a sustainable way. A growing awareness and concern regarding sustainability has, undeniably, fully reached the tourism realm (Dwyer *et al.*, 2010; Font and McCabe, 2017; Gossling and Peeters, 2015). Tourism is primarily conceived as an economic activity, the sustainability of which is contingent upon the reduction of associated social and environmental costs. The goal is to balance the wellbeing of host communities, the satisfaction of guests, and the profits of the industry while ensuring that the recreational services upon which the industry depends are maintained (Liu, 2003).

With the increasing awareness of environmental sustainability, a strong pressure comes from externally imposed government regulations to encourage practices that keep up with ecological standards (Abrate *et al.*, 2015). Beyond the legislative and regulatory efforts, key triggers to engage in environmental practices come from stakeholder demands, in specific consumers. Consumers and companies alike are looking for alternatives to mitigate pressing environmental demands resulting from continuous population and economic growth. As detailed by Ambec and Lenoie (2008), possible theoretical reasons configuring a win-win situation for environmental and economic performances may regard both the revenue side and the cost side. As to the revenue side, this happens when consumers (or some specific consumers' segments) tend to employ a company's sustainable image in purchase and consumption decision-making. Understanding the public's specific attitude towards the environment became prominent already in the 1970s (Dunlap *et al.*, 2000) and is now becoming prominent in the travel and tourism literature (Formica and Uysal, 2002).

A major question for hoteliers has been whether managers' decisions should be concerned with environmental sustainability issues. Despite hotels' managers spending substantial time and money on environmental initiatives; they are not sure whether their guests perceive their green efforts appropriately. A new type of tourist is indeed replacing the traditional one, people have different values and lifestyles, higher degrees of independence (Brunetti, Testa and Ugolini, 2011) and understanding these new needs and values has become a key issue in the tourism industry. The importance of having not only effective green practices, but also coherent communication of environmental practices to stakeholders (Siano, 2012; Testa *et al.*, 2018) is therefore of paramount importance. Hotels have recently received much attention, with awareness of the negative impact that they may have on the environment (Kasim, 2004). Environmentally sensitive tourist choices have gained importance in recent years. More and more eco-conscious customers look for hotels following practices to protect the environment (Han *et al.*, 2018; Han and Yoon, 2015; Manaktola and Jauhari, 2007). Thus, the positive marketing of environmentally friendly practices can be an effective strategy for a hotel looking to promote its public image, positioning them effectively and achieve competitiveness (Erdem and Tetik, 2013), as well as achieving a potential reduction in operating costs, especially in the case of building and utility costs (Lee *et al.*, 2010).

However, research into green marketing is still incipient (Chan, 2014). Overall, despite the plethora of research about hotel attributes in general, studies examining the importance of green attributes have been relatively limited (Dolnicar and Otter, 2003; Watkins, 1994; Kasim, 2004). In a quite dated study, Watkins (1994) found that frequent travellers would stay in hotels with environmental strategies, but they would not be willing to pay a price premium for those rooms. His study also indicated that the environmentally friendly hotel attributes that travellers consider when selecting a green hotel included recycling bins, energy-efficient lighting, recycled paper for promotional materials, changing sheets only when requested, and turning off lights in unoccupied guestrooms (Watkins, 1994).

Despite the passing of 25 years since that study, researchers have provided little information on how environmental hotel efforts are evaluated by consumers. This is even more surprising considering the growth of digital platforms and the diffusion of consumers' evaluations in the format of both online textual reviews and ratings. A large body of the literature have proven that online ratings have significant business value, affecting positively both purchase intentions and

willingness to pay (e.g. Mauri and Minazzi, 2013; Abrate and Viglia, 2014). Another stream of literature focuses on measuring the antecedents of overall customer rating (e.g. Zhao *et al.*, 2019). In both cases, the eventual role of environmental aspects is largely ignored. One recent exception is D'Acunto *et al.* (2018), who investigated how consumers assess the environmental dimension of corporate social responsibility from the textual reviews on TripAdvisor.

This paper attempts to contribute to the identified gap related to guests' perceptions of the environmental policies put in place by the hotel. In particular, the research tests whether the hotel's environmental performance evaluated by guests is a foundation for the hotel's overall evaluation. The case study refers to a big hotel chain, specifically includes 105 European hotels and presents two main peculiar features. First, while the hotel group declares its commitment in promoting eco-friendly projects, it does not position itself as a "green" hotel and targets a broad kind of consumers who are not specifically green. Thus, differently from the literature focusing on specific niches of environmentally-conscious market segments, the goal of the paper is to understand if the 'average' consumer cares about environmental policy. Second, the empirical analysis uses customers' reviews from a hotel chain's internal platform. Among the various hotel review items (such as location, service, and so on), this internal survey specifically requests for a guest evaluation of the environmental policies. This is a key distinction with respect to all the popular open online review platforms, which lack of a specific review item dedicated to sustainability. Thanks to this feature, it is possible to develop a quantitative approach to measure the way each partial assessment given to some specific aspects of the guest experience - including the assessment of the environmental policy - contributes to the overall rating.

Few issues in tourism research are so practically relevant to the industry as the investigation of the role hotel attributes play in the consumers' minds. Knowing the attributes that determine accommodation choice, the features that are perceived as being important in a hotel and the hotel characteristics that lead to higher customer retention enables hotel managers to make optimal hotel development decision. Focusing the attention on the role of environmental policy, seen as an attribute of the overall experience, the paper discusses practical implication for the promotion of sustainable development of the hotel industry.

2. The drivers in environmental policies adoption by hotels

Increasingly, companies are implementing corporate social responsibility and sustainability practices, either as 'stand-alone' commitments, or integrated in an environmental management system (Segarra-Oña *et al.*, 2012). However, for a long time managers have associated environmental protection with additional costs imposed by government, which in turn erode a firm's global competitiveness. This view relies on a basic paradigm according to which markets work well to reach optimal use of scarce resources, so that government intervention is useful only for redistributing revenues, or when markets are no longer fulfilling their role effectively (Ambec and Lanoie, 2008). This is precisely what occurs in the case of environmental problems. However, during the last two decades, a new paradigm called "triple-bottom-line" or "triple-P" (Planet, Profit, People) has emerged (Elkington, 1998), stemming from a threefold notion of corporate responsibility involving environmental and social - besides strictly economic - factors. This paradigm has been supported by a number of studies (e.g. Porter and van der Linde, 1995) that propose a number of ways thanks to which improving a company's environmental performance can positively affect better economic performance. Ambec and Lanoie (2008) show that the expenses incurred to reduce pollution can be offset by gains made elsewhere. This more recent approach has produced in recent studies, systems, and processes to measure the level of sustainability of an enterprise, allowing for the establishment of corporate reporting based on environmental, social and economic parameters (Siano, 2012).

Research into the reasons for, and effects of, such environmental commitments has mainly focused on manufacturing industries (Johnstone and Labonne, 2009). However, the role of environmental concerns is increasingly investigated in the service industry (Cainelli *et al.*, 2011),

and particularly in the tourism and hospitality industry (Erdogan and Tosun, 2009; McNamaraa and Gibson, 2008; Segarra-Oña *et al.*, 2012; Tzschentke *et al.*, 2004, 2008). Hotels are progressively implementing environmental policies and practices, and pursue official certifications for their initiatives.

A green hotel is an environmental-friendly lodging property that initiates and follows ecologically sound programs/practices (e.g., water and energy savings, reduction of solid waste, and cost saving) to help protect our planet (GHA, 2008). When green management was first introduced, the major reasons for a hotel to "go green" centred on complying with government regulations and saving money by reducing waste and energy usage (Lee *et al.*, 2010). A plethora of drivers lead hotels to pursue environmental sustainability beyond government regulations. Factors such as; a manager's disposition (Park *et al.*, 2014); response to public scrutiny, to enhance employees' job satisfaction and commitment, to improve investor relations, or for moral reasons (Rahman *et al.*, 2012).

In sum, several environment-focused green initiatives have been executed. Gilg *et al.*, (2005) emphasized the three *Rs* - reduce, reuse, and recycle - and two *Es* - energy and efficiency - as the core definitional elements for distinguishing green from non-green initiatives. Drawing upon related literature (Dutta *et al.*, 2008; First, 2008; Cordano and Frieze, 2000), we identified five categories of environment-focused green initiatives revolving around the notions of three Rs and two Es: (1) recycling and composting (First, 2008), (2) renewable power (Fahmy *et al.*, 2012), (3) pollution prevention and reduction (Cordano and Frieze, 2000), (4) energy efficiency and conservation (Lee *et al.*, 2013), and (5) water efficiency and conservation (First, 2008). Predominantly the financial benefits and increased competitiveness are often pointed out as primary reasons for hotels to implement sustainability activities (Claver-Cortés and Pereira-Moline, 2007; Kang *et al.*, 2010; Kim and Han, 2010; Molina-Azorin *et al.*, 2009; Rahman *et al.*, 2012; Segarra-Oña *et al.*, 2012; Tarí *et al.*, 2010). Potential reduction in operating costs, especially in the case of building and utility costs are strong reasons to engage in environmental policies as well (Rahman *et al.*, 2012). By making minor changes in the construction, building management and use of technology, energy usage can be reduced by 20% in existing buildings and 50% in new buildings (ibid), water usage can be reduced by 40%, and better management of waste disposal can result in a cost saving of 25% (Hawkins, 2006).

With the growing number of customers seeking green operations, being a green hotel can provide a basis for good marketing strategies in that its environmental-friendly practices may help position it differently in the competitive arena (Manaktola and Jauhari, 2007). In addition to gaining a competitive edge, differentiating themselves from similar, but non-green operations, and fulfilling customers' needs for environmentally friendly hotels, appear to be strong drivers. A green hotel's overall image can contribute to more favourable behavioural intentions (Han *et al.*, 2010).

However, whether being committed to environmental-friendly initiatives can be useful only to target specific and limited niches of the market or that such sustainable initiatives can be recognized by the "average" consumer as a significant attribute of its overall experience remains unclear.

Despite the efforts, the tourism industry is still known as one of the least developed industries in regards to the implementation of sustainability policies (Smith and Feldman, 2003), and leading European hotel chains are accused of lagging behind comparably sized corporations from other industries (Lane and Hill, 2006).

3. Guests' perceptions of environmental hotel practices

Today, society judges firms on their business ethics, social accountability and socio-economic awareness as well as financial outcomes. As public understanding grows about global warming and climate change, stakeholders including employees and customers, expects hotels to act on their understanding (Han *et al.*, 2011). This global trend guides hotels to move in a green direction. As this research suggested, a green hotel image becomes a powerful operational tool in attracting and retaining more guests. Incorporating (functional and emotional) green positioning into hotel

operations is prerequisite for the creation of a green hotel image (Lee *et. al.,* 2010). Such authors suggest that a green hotel's overall image favourably enhances behavioural intentions. Greening a hotel appears to be inevitable in order to meet hospitality customers' increasing green needs and boost their positive intention and behaviour toward the firm (Han *et al.,* 2011; Han and Hyun, 2018).

The major motive for guests to select a green hotel is to achieve the sense that their purchase decision contributes to saving the planet and leaving a green environment for their children. These emotional benefits can be classified as follows: (1) a feeling of wellbeing inspired by an altruistic behaviour (Ritov and Kahnemann, 1977), (2) auto-expression benefits associated with socially conscious consumption of green products/services (Belz and Dyllik, 1996) and (3) a feeling associated with nature, such as loving nature and having an emotional fondness for nature (Kals *et al.,* 1999).

Prior studies confirm the relevant role of environmental consciousness as a moderator in the relationship between a company's green image and consumer behaviour. Martínez *et al.,* (2018) demonstrate that customer perceptions of green practices act as a major driver when choosing a certified hotel (Han *et al.,* 2009). Oliver (1996) defined "green satisfaction" as "a pleasurable level of consumption-related fulfilment to satisfy a customer's environmental desires, sustainable expectations, and green needs". The measurement of green satisfaction includes four items: (1) You are happy about the decision to choose this brand because of its environmental commitments; (2) You believe that it is a right thing to purchase this brand because of its environmental performance; (3) Overall, you are glad to buy this brand because it is environmental friendly; and (4) Overall, you are satisfied with this brand because of its environmental concern. Many further steps in engaging consumers in the hotel environmental policies could still be put in place. Sustainability practices are, indeed, mainly implemented in back-of-house areas (i.e. areas where hotel guests have no access), which neglects the opportunity to involve and encourage guests to reduce their environmental impact. There are some exceptions, with hotels increasingly encouraging guests to reduce their electricity and water consumption through information stickers in bed- and bathrooms. The most commonly used sustainability practice that involves guests is the towel and linen reuse programme (El Dief and Font, 2010; Goldstein *et al.,* 2008; Shang *et al.,* 2010). This, however, can once again save the hotel considerable costs on electricity, water and cleaning products. Overall, previous research is consistent in suggesting this green turn (Han *et al.,* 2011).

On the other hand, a few studies in consumer behaviour seem to produce controversial findings related to the importance consumers give to marketing social responsibility issues. Belk, Devinney and Eckhardt (2005) show how there is a general lack of consumer concern for ethical issues in general across cultures. Carrigan and Attalla (2001) propose that despite consumers are more aware and sophisticated, this does not necessarily translate into behaviour, which favours ethical companies and punishes unethical firms.

4. Methodology

4.1 Overview of the study

The unit of analysis in this research is the consumer level, in specific guests, both professional and leisure guests, of an international hotel group who have provided an evaluation of their overall experience.

A case-study strategy was chosen because it offers new insights into a phenomenon of which little is known (Eisenhardt, 1989). The case study aims at theory building (Eisenhardt, 1989) and is particularly useful in forming a holistic view of context-specific and complicated situations and topics. (Halinen and Gornroos, 2005; Yin, 2003). The study adopts a sequential transformative mixed-method approach (Creswell *et al.,* 2003, p. 182).

- A quantitative analysis on a dataset of 52,764 observations coming from internal platform, which specifically requests for a guest evaluation of the environmental policies.

- A subsequent qualitative semantic analysis on the open-ended textual reviews coming from both internal data (the company's internal survey) and public, external (Booking.com, Google, Expedia, and TripAdvisor).

A mixed-method research approach improves the overall validity of results by permitting triangulation of the findings. In this specific study, the qualitative results are meant to complement and confirm the main quantitative analysis, making the study of greater use.

The empirical analysis has selected an international context, benefiting from the collaboration of the NH Hotel Group. NH is an international hotel group with a focus in Europe with a portfolio of 350 hotels, across multiple urban destinations, catering for both business and leisure users, positioned as an mid and upscale range hotel group, within the top 50 worldwide.

Empirical data were verified and triangulated with interviews with the company's management and with secondary sources (internal reports, confidential material, digital data from the website) to obtain a fuller and more precise perception of the context, and to enhance the reliability of the research (Eisenhardt, 1989; Yin, 2013). This study applied an internal questionnaire survey to verify the research question.

The hotel group's sustainable commitment is communicated through different channels. A powerful platform is undoubtedly the digital one, where through its website, the company communicates its strategic environmental plan and results. The company engages in various ecologically sound practices (among which we find for example the Carbon Disclosure Project (CDP); Spanish Green Growth Group; #PorElClima Community; One million Commitments for Climate Change promoted by the United Nations) that aim to reduce the emissions generated by hotels and the activities that take place in them.

On the website, sustainability is claimed to be a strategic value for the hotel group, acting as a cross value enabler to build the future of the company which keeps on investing in innovation in order to develop eco-efficient solutions. 61% of European hotels have some type of renewable energy supply in accordance with Directive 2009/28 / EC to promote the use of renewable energies in the European Union.

Since 2007, the company has reduced energy consumption by 34% per room. This reduction is possible thanks to the several measures implemented by the Company. Around the energy efficiency concept is the constant consideration of opportunities to improve building's energy performance (e.g. replacement of equipment to achieve greater efficiency, explore new technologies, actions to improve insulation, selection of the right light bulbs, best minibars, washing systems, heating and air/conditioning equipment).

Since 2007, the company has reduced water consumption by 31%. This reduction has been made possible thanks to the sustainable measures implemented by the Company (selection of best equipment, saving systems of faucets, showers and toilets, recycling greywater, reuse of water for irrigation and reduction systems in swimming pools).

From a marketing point of view, the company's commitment is also enacted by different new proposals. Among such new services the website promotes the "eco-friendly meetings" for company events that enable clients to organise carbon neutral meetings, and making up for any impact by supporting sustainable development and climate change projects. A compensation for emissions is also offered, thus achieving a smaller impact on the environment.

In sum, despite the fact that environmental practices are not part of the company's core services or core competencies and it does not position itself strictly as a "green" hotel that bases its competitive advantage on its environmental posture, the company enacts rigorous environmental policies that are strongly communicated digitally. Consequently, the company markets itself to a broad kind of consumers who are not specifically green.

4.2 Quantitative method

The hotel chain analyzed in the case study monitors reviews over different platforms: open online platforms, such as TripAdvisor, Booking.com, Google, Expedia and an internal platform designed to question specific aspects of the consumer experience. In comparison to the public

platforms, the peculiarity of the internal platform is the request for a specific guest evaluation of the environmental policies. Thus, this unique source of data is perfectly suitable for the main purpose of our study, that is investigating the way the guest perception of the hotel environmental commitment of the hotel influences the overall guest evaluation of his/her experience.

The dataset includes all consumers' reviews on a sample of 105 hotels in 8 European cities: Amsterdam, Barcelona, Berlin, Brussels, Frankfurt, Madrid, Milan, Rome. The data are the result of a survey carried out by the hotel chain and is administered a week after a guest checked-out and invites the guest by email offering him/her a 15% discount on his/her next stay (see Appendix 1).

The analysis covers the period from January 2017 to October 2018, with a total amount of 84,470 consumers' reviews on the internal platform. Each review assesses the quality along 11 different dimensions, namely: overall evaluation (*OVERALL*), cleanliness (*CLEAN*), value for money (*VALUE*), staff friendliness and service (*SERV*), quickness and efficiency in check-in and check-out (*CHECK*), location (*LOC*), room and bathroom (*ROOM*), food and beverages (*FB*), installations (*INST*), sleep quality (*SLEEP*) and environmental strategy (*ENV*). For each dimension, the consumer has to provide a distinct quantitative score on scale 1 to 5 (also the overall score is a distinct score, thus, it is not the average over the other dimensions).

Table 1 provides a summary of the available data. Some reviews contain only partial information, because the consumer might not provide an evaluation on every single item. However, the large majority of quality dimension displays a frequency of missing values that is lower than 1 percent. A little higher is the number of cases that does not provide an assessment of the value for money (2.5 percent), while the incidence is much more evident for two specific assessments: *FB* and *ENV*. While for the case of *FB* it is natural associating this missing values to guests that are not consuming any food and beverage (or breakfast) at the hotel, the number of missing associated to the environmental policy is itself a significant data to worry about. One consumer over four approximately does not give any evaluation on environmental policy, and this could reflect indifference or maybe inability to assess this dimension. The total number of reviews presenting complete information on all the specific items is equal to 52,764.

As to the score levels, the overall experience is rated on average pretty good (4.28 over 5), which is quite in line with the scores one can find in booking.com for 4-star rated hotels (provided they are rescaled in scale 1 to 10). Guests tend to be a bit more critic when assessing the value for money, which highlights the lowest average score (3.98), while the service has the highest score (4.48). The scores over the different dimensions clearly exhibit a high degree of correlation, as shown in Table 2, though the value of correlation never exceed 0.7. Moreover, a regression of *OVERALL* score on all the other dimensions signals an average Variance Inflation Factor (*VIF*) equal to 2, with a maximum *VIF* of 2.54, excluding major problems due to multi-collinearity (Hair *et al.*, 2010).

Tab. 1: Descriptive statistics

Quality dimension	N. of observation	(% missing)	Average score	(standard deviation)
OVERALL	84,470	(0.00%)	4.28	(0.86)
CLEAN	84,113	(0.42%)	4.36	(0.85)
VALUE	82,386	(2.47%)	3.98	(0.89)
SERV	84,007	(0.55%)	4.48	(0.78)
CHECK	83,964	(0.60%)	4.41	(0.83)
LOC	84,166	(0.36%)	4.32	(0.79)
ROOM	84,233	(0.28%)	4.18	(0.92)
FB	70,126	(16.98%)	4.16	(0.85)
INST	83,853	(0.73%)	4.16	(0.92)
SLEEP	83,963	(0.60%)	4.31	(0.87)
ENV	63,333	(25.02%)	4.18	(0.76)

Source: our elaboration

Tab. 2: Correlation Matrix

	OVERALL	*CLEAN*	*VALUE*	*SERV*	*CHECK*	*LOC*	*ROOM*	*FB*	*INST*	*SLEEP*	*ENV*
OVERALL	1										
CLEAN	0.62	1									
VALUE	0.69	0.53	1								
SERV	0.61	0.49	0.49	1							
CHECK	0.57	0.46	0.47	0.66	1						
LOC	0.42	0.35	0.38	0.36	0.34	1					
ROOM	0.69	0.68	0.60	0.46	0.44	0.36	1				
FB	0.53	0.42	0.48	0.47	0.41	0.37	0.43	1			
INST	0.59	0.56	0.50	0.43	0.42	0.33	0.60	0.43	1		
SLEEP	0.61	0.51	0.51	0.50	0.48	0.34	0.56	0.41	0.54	1	
ENV	0.58	0.53	0.55	0.52	0.52	0.42	0.53	0.51	0.52	0.52	1

Source: our elaboration

The quantitative analysis aims at assessing the relative components of the overall score given by the guest. In other words, the assumption is that the overall evaluation can be seen as a weighted average of the partial assessments given to the specific aspects of the guest experience. To disentangle these relative weights, the empirical analysis employs a constrained linear regression model, as follows:

$$OVERALL = \beta_0 + \sum_i \beta_i i + \varepsilon$$

$$i \in \{CLEAN, VALUE, SERV, CHECK, LOC, ROOM, FB, INST, SLEEP, ENV\}$$

$$\sum_i \beta_i = 1$$

The sum of the parameters β_i is constrained to 1, in a way that each parameter associated to the specific quality dimension can be interpreted as the relative importance of the specific quality item on the overall experience. The usual white noise assumptions hold on the error term ε.

4.3 Qualitative method

The qualitative phase of the research aims to complement the first quantitative phase of the study investigating weather and in which terms consumers assess hotels' environmental practices when they write a review about their accommodation experience. A semantic content analysis was performed on the open-ended textual reviews coming from both internal data (the company's internal survey) and public data coming from peer-to-peer platforms (Booking.com, Google, Expedia, and TripAdvisor). Regarding reviews (both internal and public) text is important because it includes affective words, conveying positive and negative emotions and strengthening the intent of a review. Content and narrative analyses of consumer reviews have attracted considerable attention in recent studies in order to gain insight about consumption experiences. Service features consumers care about can be highlighted, and more detailed interpretations of their perceptions can be provided (e.g. Zhao *et al.*, 2019).

5. Results and discussion

5.1 Quantitative Results

Table 3 presents the results of the constrained linear regression on the full sample. The most important factor appears the value for money (with a weight near to 25%), followed by the quality of the room (19.5%) and the service (16%). The most striking result is that all partial evaluations

but the environmental policy have a weight significantly different from 0. This suggests that guests, when evaluating the overall experience, not seem to take into account their own evaluation on the environmental policy. One useful measure of the accuracy of the model is the Median Absolute Percentage Error (MdAPE) between the forecast obtained by applying the estimated parameter and the real values of the dependent variable. This value is equal 5.1 percent, with a significant improvement with respect to a naïve model weighting all factors equally (in that case the MdAPE would be equal to 5.6 percent).

Tab. 3: Results

Explanatory variables (*i*)	**Estimated β**	**(t-statistics)**
CLEAN	0.068**	(17.75)
VALUE	0.247**	(74.09)
SERV	0.158**	(40.05)
CHECK	0.067**	(18.41)
LOC	0.028**	(9.48)
ROOM	0.195**	(53.67)
FB	0.073**	(23.00)
INST	0.069**	(21.59
SLEEP	0.095**	(28.30)
ENV	0.000	(-0.13)
Constant (β_0)	0.074**	(29.34)
Root Mean Square Error	0.9417	
MdAPE	5.12%	
Number of observations	52,764	

** p-value <0.01; * p-value<0.05

Source: our elaboration

One limit of the above model is the assumption that all guests give the same weights to the different factors. One possible option to refine the analysis is resorting to clustering. Cluster analysis is a method for multivariate data that allows grouping observations based on a set of selected characteristics. The resulting groups are more homogeneous and can be interpreted as different segments of consumers. Specifically, the k-means algorithm (MacQueen, 1967) is an iterative algorithm that assigns each observation to a predefined number of cluster, in a way to minimize the sum of the squared Euclidean distances between the observations and their cluster centroid (arithmetic mean of all the data points belonging to that cluster). The input variables for the k-means algorithm are all the quality dimensions of the review and the number of clusters has been set to three, in consideration of pursuing both accuracy and parsimony objectives.

Table 4 show the results of the constrained regression model applied to the three identified clusters, which define three distinct consumer profiles. The first group (around 50 percent of the sample) might be defined as the "service-oriented" consumer, and gives the highest importance to the service dimension, as well as to the cleanliness and check-in and check-out. This type of guest gives particular importance to the human interaction with employees, that is, the social servicescape. The second group of consumer (around 9 percent of the sample) is instead more practical and "value-oriented". In fact, almost 40 percent of the overall evaluation depends on his rating in terms of value for money. The dimensions reflecting human interactions assume the lowest weights, while major importance is given to the physical tangible attributes, such as room facilities, installations and sleep quality. Finally, the third group of consumers (the remaining 40 percent of the sample) tends to average across all types of evaluations.

The predictive power of the model improves reducing the MdAPE to 4.3 percent. Focusing on the main goal of the analysis, results confirm that environmental policy is the least important factor in consumers' overall evaluation of the accommodation experience. This holds also in the third cluster of consumers, which however gives at least a certain attention to the environmental policy (4 percent).

Tab. 4: Results after clustering

	Cluster 1 "Service-oriented"		**Cluster 2 "Value-oriented"**		**Cluster 3 "Neutral"**	
Explanatory variables (*i*)	**β**	**(t-statistics)**	**β**	**(t-statistics)**	**β**	**(t-statistics)**
CLEAN	0.109**	(17.90)	0.037**	(3.51)	0.058**	(9.92)
VALUE	0.132**	(33.52)	0.403**	(34.09)	0.256**	(45.40)
SERV	0.239**	(35.64)	0.150**	(14.00)	0.128**	(21.18)
CHECK	0.105**	(18.29)	0.057**	(5.55)	0.053**	(9.67)
LOC	0.061**	(15.45)	0.034**	(3.46)	0.071**	(14.86)
ROOM	0.139**	(27.18)	0.152**	(13.29)	0.164**	(28.36)
FB	0.077**	(18.87)	0.026*	(2.44)	0.095**	(19.08)
INST	0.048**	(11.03)	0.069**	(6.90)	0.060**	(11.82)
SLEEP	0.081**	(15.81)	0.097**	(10.04)	0.074**	(14.44)
ENV	0.009*	(2.15)	-0.026	(-1.92)	0.040**	(6.31)
Constant (β_0)	0.170**	(30.92)	-0.289**	(-11.33)	0.165**	(18.12)
Root Mean Square Error	0.7074		1.3055		1.0320	
Number of observations	26,998		4,545		21,221	
MdAPE	4.33%					

** p-value <0.01; * p-value<0.05

Source: our elaboration

5.2 Qualitative findings

The analysis searched for specific keywords (i.d. *sustainability, green, environmental* in English and Italian), producing extremely limited results. Out of 25,117 Italian and 68,389 English reviews only 28 mentioned environmental issues (20 from the internal survey and 8 from public data coming from Booking.com, Google, Expedia, and TripAdvisor). This result is inverted compared to the overall number of textual reviews (28% originate from the internal survey and 72% from the public platforms). In any case, the environmental discourse in the textual review of the accommodation experience is, undeniably, scant. As such, the qualitative semantic analysis complements the quantitative study without however producing the rich insights that qualitative research potentially is able to provide. Despite the paucity and the quality (very few words when present) of the reviews, the data can nevertheless be categorized in the following themes. First of all, the study reveals that the environmental elements are mainly associated with negative emotions (over 2/3) and regard negative hotel behaviours about waste and energy management. Indeed, the few positive comments (3 out of a total of 28) are quite generic just mentioning environment "*Environmental policy*" (Booking.com). One comment refers, instead, to CSR activities: "*I loved … promoting local artists through custom art pieces in each room and art which funds environmental causes; like the Chinese elephants conservatio*n" (Expedia).

The main negative comments that emerge from the reviews regard *energy consumption* often mention the specific towel re-use policy during the stay (13 out of 28 reviews). The following excerpt reflects the reviews on this issue: "*Regarding environmental profile - it is frustrating with signs 'hang up towels if you want to re-use' when towels is changed anyway*" (Internal survey) or "*Like all the hotels we stayed at in Spain, they claimed to want to be eco friendly by not washing towels*" (TripAdvisor). A second negative issue refers to the hotel's *waste management* practices, as the following review suggests: "*The wastage of food on such a large scale was absolutely horrendous, and as an environmentally conscious group quite shocking*" (TripAdvisor). Or: "*Environment is very important to me. The high level of service sometimes did not align with the important and worthy environmental strategy of NH Hotel Group. For example … the bar of soap was renewed very often, despite being only very lightly used. One bar in the wash - sink and one in the shower were more that enough for the duration of 4 days"* (Internal Survey). Along the same lines: "*The hotel has no environmental awareness. No possibility to recycle garbage at the rooms.*

No environmental friendly products (soap, shampoo, etc). No organic food. Sugar, butter were all in small packages producing unnecessary garbage" (Internal Survey).

Additionally, a suggestion to market more powerfully the company's environmental commitment is put forward by the following neutral review: "*Market all environmental work done in the hotel, I learnt it from one of the managers of the hotel chain. As a guest there is only a certificate in the reception, no info in the room or elsewhere*" (Internal Survey).

The negative reviews reflect a general perception of misalignment and scant adherence between the company's actual practices (e.g. towels' changing activity) and its environmental commitment. Consumers that write negative reviews on this issue are, indeed, aware of the general commitment the company claims, and perceive a strong gap with current behaviours. The paucity of the content generated by guests mentioning environmental issue, both through the internal and external platform, is to be considered itself a finding, confirming the limited relevance environmental policies have in guests' mental model of an overall accommodation experience.

6. Discussion and conclusions

Environmental policies have been widely recognized as a prominent strategy for hotel businesses and have thus received substantial attention from hospitality and tourism scholars (Geerts, 2014; Han *et al.*, 2011). While previous research has examined guest participation intention for green hotel practices, willingness to pay, and loyalty intention (e.g. Han *et al.*, 2018; Han and Hyun, 2018), the way consumers evaluate environmental policies has been overlooked by researchers, also because of the absence of a specific review item dedicated to sustainability in the popular open online review platforms. Thanks to a unique source of data from a hotel chain's internal platform, this research investigates how consumers assess hotels' environmental policies and whether such evaluation influences their overall satisfaction. An overall satisfaction is a multi-dimensional construct. The quantitative model allows assessing the way each partial evaluation, given to a specific aspect of the guest experience, contributes to the multi-dimensional overall evaluation. In a hotel context, both the social servicescape (i.e., interactions with employees) and physical servicescape (i.e. building, landscape and interior facilities) drive consumer satisfaction.

Our main contribution to the marketing and tourism literature lies in the unveiling that green practices are "nonessential attributes" that seem to have very limited relevance in consumers mental models of an accommodation experience. Despite the increasing concern and awareness in environmental issues from governments, companies, and other stakeholders, consumers don't seem to perceive these issues as relevant. Our findings indicate that high values in environmental policies are not reflected in high values of the overall evaluation. Simply put, a good evaluation of the company's environmental policies does not enhance an overall consumer satisfaction. .

The results of this study can be explained in a number of ways. A first straightforward explanation can suggest that hotel guests are just indifferent to the hotel environmental policies or, second, individuals are unable to assess this dimension due to a lack of information on what the hotel is enacting. The overarching nature of 'environmental strategy' is maybe too complex for the guests to evaluate quickly. The ability of a hotel to signpost clearly to guests what actions and environmental policies it is enacting may also impact on the ability of the guests to comment on policies, as they may remain unseen' by guests if not explicitly signaled during a stay. An alternative view could be that guests may expect certain environmental policies as 'normal' hotel behaviour, such as the towel re-use policy and therefore not consider it worth commenting on.

Regarding the open peer-o-peer platforms the fact that environmental policies is not an item that consumers are asked to rate may lead to a poor perceived relevance when filling out the review. When completing the review, consumers may just not think of mentioning any environmental content because there is no previous reference to it in the rating section. We cannot avoid, however, suggesting that these poor results could reflect the fact that environmental issues are not key pillars in consumers' mental models of an overall satisfaction of an accommodation experience.

From a managerial standpoint this study provides three implications. The first regards the need to raise consumer relevance and awareness regarding environmental issues. This study recommends that hotels invest more in communicating environmental practices that can be "experienced" directly by consumers (e.g. water management during room cleaning) which could also include their participation (e.g. towel re-use activity) moving beyond the practices implemented in back-of-house areas (i.e. areas where hotel guests have no access) which are not noticed by consumers. Second, consistently to raising the relevance of environmental issues, hotel management should make their environmental commitment known beyond the content on the website and the few communication artefacts within the hotel. The company's environmental positive achievements that are described at present on the website could as well create awareness and relevance in consumers' mental models if communicated more broadly. As suggested by the qualitative results, to deal with this, frontline employees (such as receptionists and service staff) should be properly trained in explaining environmental programs. In this direction, consumers not only are stimulated to become involved in environmental initiatives but also an increase in relevancy of environmental issues may be facilitated. Third, company's practices should always be consistent with the environmental commitment it claims having. The company must consistently implement the environmental policy communicated to consumers, especially the ones that invite consumers' participation (e.g. towel re-use activity). If not, the simple communication can backfire because it raises consumers' expectations without "walking the talk".

This study has also implications for the open peer-to-peer platforms. The inclusion of a specific review item on environmental strategy could promote environmental discussion contributing to an increase of consumers' awareness and relevance of such issue. Moreover, results suggest caution in relying on demand side support towards the implementation of environmental-friendly strategies. Thus, regulation continues to play a crucial role in promoting the sustainability of the hotel industry.

This study presents a few limitations that further research should mitigate. First, despite the uniqueness and richness of the dataset (more than 50,000 reviews for the quantitative study and almost 100,000 observations for the semantic content analysis), the information is limited to a single hotel chain. Whilst important aspects of this research can be transferred to, and have relevance for, a case study research design limits the generalizability of its findings. Second, both quantitative and qualitative data analysis could be deepened through other kind of research methods; a further in depth face-to-face analysis with consumers could help to unveil and unpack what environmental policies mean to them. The data collection methods used in this research to evaluate environmental factors have been effective in capturing a general picture but a more delicate qualitative tool would be able to unlock a more nuanced set of responses. Future research could disentangle the motivation of the results (e.g. little care about the environment or inability to make the assessment), also by means of experimental settings. Third, the research is limited to the analysis of consumers' post-consumption reviews, without investigating ex-ante consumers' purchase intention and willingness to pay. Finally, the qualitative semantic analysis focused on a limited number of keywords, future research should include a broader dictionary, as done in D'Acunto *et al.*, (2018) on a TripAdvisor reviews database.

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Appendix 1: Excerpt of survey questionnaire

Select your language > ENGLISH

nH | HOTEL GROUP | nH HOTELS | nH COLLECTION HOTELS | nhow HOTELS

NH COLLECTION ABASCAL

NH SATISFACTION SURVEY

We would like to know what you think of staying at the hotel. Your comments will help us improve our service and will be treated anonymously. Please, value your satisfaction regarding the following concepts:

Are you travelling on:	Meeting at the hotel	Leisure	Business

	Very unsatisfied	Unsatisfied	Quite satisfied	Satisfied	Very satisfied	Don't apply
OVERALL HOTEL SATISFACTION	☆	☆	☆	☆	☆	?
How likely are you to recommend this hotel to a friend or collegue?	☆	☆	☆	☆	☆	?
Value for Money	☆	☆	☆	☆	☆	?
Hotel Location	☆	☆	☆	☆	☆	?
Room and Bathroom	☆	☆	☆	☆	☆	?
Cleanliness	☆	☆	☆	☆	☆	?
Hotel systems (air conditioning, heating, water, …)	☆	☆	☆	☆	☆	?
Breakfast buffet quality and variety	☆	☆	☆	☆	☆	?
Other Food & Beverages Services (quality and variety)	☆	☆	☆	☆	☆	?
Staff friendliness	☆	☆	☆	☆	☆	?
Sleep Quality / Pleasant Rest	☆	☆	☆	☆	☆	?
Check in / Check out process (efficiency and quickness)	☆	☆	☆	☆	☆	?
Environmental strategy of the hotel	☆	☆	☆	☆	☆	?

What did you like in this hotel? (max. 400 characters) — Answer here…

What can we do to improve our service? (max. 400 characters) — Answer here…

	YES	NO
Regarding your suggestions, would you like to be contacted by NH Hotel Group?	✓	✗
Do you want to help other travelers? If you click "Yes", we will publish your comments and your first name on our web, so that other travelers can read the opinion of real customers.	✓	✗

SEND

Consapevolezza e sensibilità dei turisti per offerte di turismo sostenibile. Logiche di interpretazione ambientale per la valorizzazione delle aree naturali

SILVIA PEDERZOLLI GIOVANAZZI* FEDERICA BUFFA•
PIER LUIGI NOVI INVERARDI♠ UMBERTO MARTINI**

Abstract

Obiettivi. *Analizzare se i visitatori delle aree naturali sono riconducibili ai turisti interessati ad offerte di turismo sostenibile come sintetizzato dal turismo 4L (leisure, landscape, learning, limit) e analizzare se e come scelte di valorizzazione della dimensione educativa della vacanza e di interpretazione ambientale sono convincenti per rispondere alle aspettative latenti piuttosto che manifeste della domanda 4L.*

Metodologia. *Indagine statistica rivolta a visitatori e operatori in un'area naturale di particolare pregio e interesse: la Val di Tovel (Trentino). L'indagine ha coinvolto un campione casuale di 764 visitatori e 22 operatori locali. Ulteriori 86 interviste sono state condotte con stakeholder privilegiati approfondendo specifici focus di indagine. L'analisi si basa su statistiche descrittive, analisi delle corrispondenze multiple e analisi dei cluster gerarchica condotta con criterio di aggregazione di Ward per confrontare le valutazioni di visitatori e operatori.*

Risultati. V*erifica della coerenza dei visitatori delle aree naturali con i turisti 4L e ricostruzione del livello di consapevolezza e sensibilità. Conferma della presenza di logiche di educazione e interpretazione ambientale per la valorizzazione dell'area naturale e proposta di strumenti ed iniziative ad integrazione di quelle esistenti.*

Limiti della ricerca. *La ricerca si avvale di campioni statisticamente rappresentativi di visitatori e operatori, ma limitatamente ad un solo caso di studio.*

Implicazioni pratiche. *Identificazione di best practice per l'adozione di scelte di interpretazione ambientale nella gestione delle aree naturali.*

Originalità del lavoro. *Lo studio contribuisce ad accrescere le conoscenze nell'ambito delle logiche di educazione ed interpretazione ambientale rivolte ai nuovi segmenti di domanda turistica.*

Parole chiave: *logiche di interpretazione ambientale; turista 4L; sostenibilità; risorse naturali; aree protette; Val di Tovel.*

Objectives. *Analysis about whether visitors of natural areas could be connected to tourists interested in sustainable tourism offer as summarized by 4L tourism (leisure, landscape, learning, limit) and analysis if and how strategies, to enhance the educational dimension of the holiday and the environmental interpretation, are convincing choices for satisfying the latent rather than the evident expectations of the 4L tourist.*

Methodology. *A sample survey has been aimed at visitors and operators in a natural area of value and interest: the Tovel Valley (Trentino). The survey involves a random sample of 764 visitors and 22 local operators. In addition, 86 interviews were conducted with key stakeholders, deepening some specific focuses of the initial survey. The analysis is based on descriptive statistics, multiple correspondence analysis and analysis of hierarchical clusters conducted with Ward aggregation criteria to compare the evaluations of visitors and operators.*

Findings. *Confirmation of the coherence of visitors to natural areas with 4L tourists and reconstruction of the level of awareness and care off. Demonstration of the presence of environmental education and interpretation strategies for the enhancement of the natural area and for the proposal of tools and initiatives for completing the existing ones.*

Research limits. *The research is based on a statistically representative samples of visitors and operators, but it is limited to only one case study.*

Practical implications. *Identification of best practices for the adoption of environmental interpretation strategies in the management of natural areas.*

Originality of the study. *The study contributes to discuss the environmental education and interpretation logics aiming at new segments of tourist demand.*

Key words: *environmental interpretation logics; 4L tourist; sustainability; natural resources; protected areas; Tovel Valley*

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1. Introduzione

Il turismo è riconosciuto come uno dei settori trainanti l'attuale economia mondiale e mostra prospettive di crescita anche per il prossimo futuro. Il World Travel & Tourism Council (WTTC, 2018) rileva in 300 milioni i posti di lavoro connessi al settore turistico e stima in 10,4% il contributo del turismo al PIL mondiale. Secondo l'Organizzazione Mondiale del Turismo, a livello globale, nel 2016, gli arrivi turistici internazionali sono stati 1.235 milioni di cui il 50% registrati in Europa.

L'indotto apportato dal turismo è il risultato di attività che inevitabilmente impattano sui territori sia da un punto di vista economico, sia da un punto di vista ambientale e sociale. Tale considerazione ha alimentato e rafforzato (soprattutto in questi ultimi decenni) il dibattito scientifico sull'importanza della sostenibilità nelle scelte di gestione delle imprese coinvolte nella filiera turistica, così come dei territori eletti a destinazione turistica.

Il turismo delle 3S (*sea, sand & sun*) caratterizzante gli anni '60, sebbene rimanga ancora oggi un'opzione di vacanza che soddisfa segmenti di domanda riconducibili al *turismo di massa*, appare sempre meno idoneo a soddisfare segmenti di turisti che manifestano interesse crescente per proposte di vacanza *green*. Molteplici sono i termini che colgono tale tendenza andando a sottolineare specifici aspetti di consumo e di comportamento della domanda turistica, piuttosto che specificità dell'offerta. È in tal senso che, negli anni, hanno trovato ampio interesse scientifico tematiche inerenti all'eco-turismo, il turismo responsabile e il nature-based tourism, solo per citare alcuni tra i principali filoni che coniugano il management del turismo con la dimensione della sostenibilità.

L'interesse per proposte di turismo sostenibile oggigiorno si conferma una tendenza in crescita (Eagles *et al.*, 2002), che identifica un turista sensibile alla protezione dell'ambiente e al rispetto delle culture locali, interessato ad esperienze autentiche di vacanza e alla ricerca di proposte che interpretano la dimensione *leisure* della vacanza con attività immersive, che lasciano spazio alla scoperta delle risorse e delle tradizioni locali (Eagles e Bushell, 2007). All'interno di questo scenario il turismo delle 3S cede il passo al turismo delle 4L (Franch *et al.*, 2008), ossia a proposte di vacanza che trovano nelle dimensioni *leisure*, *landscape*, *learning* e *limit*, gli asset sui quali definire offerte di turismo sostenibile. Tale approccio trova piena coerenza con i principali obiettivi dell'ecoturismo, ossia preservare le aree naturali che garantiscono la biodiversità, sostenere il benessere della popolazione locale e accrescere le conoscenze di turisti e operatori[1].

Il presente lavoro si inserisce all'interno di tale dibattito scientifico e muove dall'*ipotesi* che vi sia una maggiore attenzione della domanda turistica ai temi che concernono la sostenibilità. La *domanda di ricerca* è la seguente: quali logiche possono essere adottate dagli stakeholder locali per stimolare e consolidare l'interesse dei turisti che scelgono di visitare le aree naturali? In altri termini, la ricerca parte dall'assunto secondo cui l'interesse e la sensibilità dei turisti verso forme di offerta coerenti con l'approccio alla sostenibilità debba e possa essere adeguatamente stimolato (e, in una certa misura, attivato), attraverso specifiche azioni che attengono a) la natura del prodotto offerto, b) l'organizzazione dei percorsi di fruizione, c) la promozione, la comunicazione e l'informazione, d) la gestione delle relazioni con il visitatore/ospite.

L'*obiettivo della ricerca* è duplice: 1) verificare se i visitatori delle aree naturali sono riconducibili ai turisti 4L e 2) analizzare se e come scelte di valorizzare della dimensione educativa della vacanza e di interpretazione ambientale sono convincenti per rispondere alle aspettative (latenti piuttosto che manifeste) della domanda 4L.

Il paper presenta le principali evidenze (metodologiche ed empiriche) emerse da una ricerca condotta nel 2018 in Val di Tovel, un'area naturale che si estende all'interno del Parco Naturale Adamello Brenta in Trentino. La scelta di quest'area è dipesa dalle specificità che la contraddistinguono, sia in quanto risorsa naturale e paesaggistica di grande pregio e con

[1] The International Ecotourism Society (TIES) definisce l'ecoturismo come "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education" (TIES, 2015). Education is meant to be inclusive of both staff and guests." (https://ecotourism.org/what-is-ecotourism/).

caratteristiche di unicità a livello alpino, sia in termini di flussi di visitatori che la frequentano coerenti per aspettative e comportamenti con le dimensioni del turismo 4L. La scelta di tale area di studio, pertanto, ha permesso di identificare un ambito ideale in cui approfondire i temi oggetto di analisi e rispondere alla domanda di ricerca.

L'analisi si avvale di un campione casuale di 764 turisti. I questionari sono stati compilati autonomamente dai turisti. Lo stesso questionario è stato somministrato anche a 22 operatori locali appartenenti ai due principali stakeholder territoriali coinvolti nella definizione dell'offerta della Val di Tovel (operatori del parco ed esperti del Museo delle Scienze di Trento), al fine di cogliere opinioni e informazioni su specifici fuochi della ricerca e confrontandone le diverse percezioni. Dal lato dell'offerta si sono intervistati anche 86 stakeholder privilegiati identificati tra gli esperti partecipanti all'ottava "Conferenza Internazionale dei Geoparchi Mondiali UNESCO" con i quali ci si è confrontati rispetto a specifiche tematiche emerse dalle interviste ai turisti e agli operatori locali.

Il paper è organizzato in cinque principali sezioni. Nel paragrafo che segue si discutono le tematiche che concernono il quadro teorico di riferimento evidenziando trend e dimensioni che caratterizzano la domanda turistica 4L (par. 2.1) e le principali caratteristiche che concernono le scelte di interpretazione ambientale (par. 2.2). Il terzo paragrafo descrive la metodologia della ricerca; il quarto presenta il profilo dei rispondenti e il quinto illustra i principali risultati. Nel sesto paragrafo si discutono le principali logiche di interpretazione ambientale per la valorizzazione delle aree naturali. Nella sezione conclusiva si evidenziano il contributo e l'originalità della ricerca, così come i limiti da essa incontrata.

2. Rassegna della letteratura

2.1 Tendenze della domanda turistica - Il turista 4L

L'interesse da parte della domanda turistica per destinazioni che valorizzano le risorse naturali e paesaggistiche è un trend che trova sempre maggiore riscontro (UNEP, 2007; Dwyer *et al.*, 2009), così come la crescita di consapevolezza da parte del consumatore verso tematiche ambientali e di sensibilità nell'adozione di comportamenti responsabili e sostenibili (Minciu *et al.*, 2012). L'evoluzione della domanda turistica, verso una maggiore sensibilità nei confronti dell'ambiente naturale e dell'impatto generato dall'attività turistica, è stata riassunta nell'individuazione di un turismo delle 4L (Franch *et al.*, 2008). Questo tipo di turista mostra una particolare sensibilità verso la protezione dell'ambiente e verso il mantenimento della cultura locale, e cerca nell'esperienza di vacanza l'autenticità. Tale schematizzazione delinea un segmento di turisti che, negli anni, è andato crescendo. Le caratteristiche di questo segmento, infatti, sono condivise e ritrovabili nelle diverse tipologie di "turismi" che alimentano l'attuale dibattito scientifico in tema di ecoturismo, turismo responsabile e turismo nature-based (si vedano a riguardo Pröbstl-Haider e Haider, 2014; Tyrväinen et al., 2014; Bausch e Unseld, 2018). Le "4L" corrispondono ai quattro concetti di *landscape*, *leisure*, *learning*, e *limit*. Il riferimento è ad una funzione ricreativa evoluta e consapevole, in quanto l'esperienza combina il divertimento con l'autoformazione. Il paesaggio e la natura sono i fattori principali, possono essere un qualcosa da ammirare o in cui muoversi (si tratta di un turismo *nature-based*). Importante è poi la funzione di scoperta, esperienza, partecipazione nella destinazione, e l'imparare qualcosa immergendosi nella vita di tutti i giorni della destinazione (quello che viene spesso inteso anche nell'ecoturismo). Infine il limite, come consapevolezza della fruizione limitata delle risorse locali e consapevolezza degli impatti sociali e ambientali dell'esperienza (collegamento al turismo responsabile).

Il turismo delle 4L è un tipo di turismo attento al paesaggio e alle risorse naturali in una prospettiva più evoluta di ciò che costituisce il divertimento. Oltre agli aspetti naturali, di grande importanza è anche il paesaggio culturale, inteso come insieme delle caratteristiche architettoniche, storiche, culturali e socio-antropologiche di una data destinazione. Si tratta di un turismo leisure

caratterizzato da un livello di grande attenzione per l'ambiente dove si sviluppa, sia dal lato della domanda, che dal lato dell'offerta. L'attenzione all'ambiente, poi, è multidimensionale, si cerca di proteggere non solo gli aspetti ecologici dell'area, ma anche le caratteristiche sociali ed economiche. La presenza di risorse naturali eccellenti, che sono protette e rese accessibili ai turisti, ma in maniera controllata, permette pertanto alle destinazioni di accrescere il valore complessivo dell'esperienza turistica offerta.

Gli asset del turismo delle 4L sono ben riconducibili e identificabili nei megatrend del mercato turistico a livello internazionale. Dwyer *et al.* (2009), ad esempio, rilevano una maggior consapevolezza riguardo alle tematiche sociali e ambientali: le persone (in particolare coloro che vivono nei paesi sviluppati) cercano più autenticità nelle esperienze turistiche, si dimostrano più consapevoli degli effetti dei loro comportamenti di fruizione della vacanza sull'ambiente e sulla cultura delle destinazioni visitate. Molti di essi rifiutano il consumismo e abbracciano una modalità di consumo più etica, anche dal punto di vista ambientale. Un altro trend è la ricerca di esperienze fruibili in una destinazione: il turista può essere considerato un viaggiatore in cerca di esperienze, alla ricerca di un'immersione diretta nei luoghi e del contatto con la cultura locale; le esperienze di vacanza diventano occasione di divertimento, ma anche di apprendimento, addirittura di trasformazione.

Il turismo delle 4L è nature-based ossia basato sulle risorse naturali, risorse irriproducibili che rappresentano l'attrazione principale di questa forma di turismo e sono altresì le caratteristiche distintive della destinazione. Queste risorse sono rappresentate spesso da riserve naturali, parchi, aree con un'alta concentrazione di aree incontaminate e selvagge (ossia wilderness come evidenziato in letteratura). Alcune di queste aree sono totalmente naturali altre, invece, possono essere costituite da ambienti semi-naturali modificati dall'uomo. Spesso, ancora, le aree che accolgono il turismo nature-based sono aree protette. In queste zone si trova il più alto tasso di naturalità e di biodiversità essendo state istituite proprio per evitare che le risorse in esse presenti venissero sfruttate economicamente e depauperate. Il loro altissimo valore ecologico, le connessioni che spesso esistono con il patrimonio culturale e con la popolazione locale (si pensi, ad esempio, al territorio alpino con i prati sfalciati per l'alpeggio), e la consapevolezza di scarsità di luoghi naturali e indisturbati dalle attività umane, fa sì che parchi e aree protette siano "zone chiave" per lo sviluppo di forme di ecoturismo, turismo sostenibile e turismo nature-based. Queste realtà possono disporre altresì di competenze scientifiche in tema ecologico e ambientale, che possono essere trasmesse ai visitatori attraverso opportune strategie di educazione e interpretazione ambientale. Queste aree, che vengono gestite allo scopo di mantenere la biodiversità e di conservare le risorse naturali e culturali associate, sono dunque perfettamente adattabili allo sviluppo del turismo delle 4L. Esso può essere altresì una componente importante per la gestione delle aree protette, contribuendo al supporto economico per la conservazione delle specie e della natura. Come sostengono Eagles *et al.* (2002), infatti, "le aree protette hanno bisogno di turismo, e il turismo ha bisogno di aree protette". Dello stesso avviso Eagòes e Bushell (2007, p. XV) "Most protected areas constitute a prime tourist attraction and can, therefore, benefit from this fact, both financially and in terms of awareness creation. Indeed, many protected areas have successfully achieved their conservation objectives thanks to the financial resources that have been obtained through tourists'/visitors' expenditures".

Il turismo, se opportunamente gestito, oltre che fornire un supporto alla conservazione del capitale naturale, pertanto, può produrre effetti positivi in termini economici e di occupazione sulla popolazione locale.

2.2 Strategie di interpretazione ambientale: caratteristiche e finalità

La pianificazione delle forme di turismo assimilabili al turismo delle 4L implica necessariamente una riflessione e un intervento da parte del management per la gestione di due aspetti: l'aspetto ambientale ed ecologico, e l'aspetto turistico. Per quanto riguarda il primo, si tratta di adottare azioni di protezione dell'ambiente, di conservazione delle risorse naturali e di istituzione

di sistemi di monitoraggio e valutazione degli impatti sull'ambiente. Il secondo aspetto ha invece a che fare con la pianificazione turistica: va perseguito un obiettivo di sviluppo turistico dell'area (sotto il profilo economico), vanno intrapresi e considerati i benefici che lo sviluppo turistico può portare alla popolazione residente e vanno valutati gli impatti del turismo sulla comunità locale.

L'attenzione su questi due aspetti pone in evidenzia la forte relazione che esiste tra biodiversità e turismo. La natura è un elemento determinante in molte esperienze turistiche e, allo stesso tempo, lo sviluppo turistico può avere impatti negativi sulle aree naturali qualora non vi sia adeguata pianificazione e gestione dello sviluppo turistico (Schelhaas, 2007). Il legame tra valorizzazione delle risorse naturali e gestione dei flussi turisti appare pertanto evidente.

Oltre alle dimensioni naturalistiche e correlate alla biodiversità e all'ecosistema, l'ambiente naturale può essere inteso in maniera più ampia, includendo anche gli aspetti culturali legati a quel territorio. Spesso infatti le attività umane hanno contribuito a mantenere la biodiversità degli ambienti e sono state legate alle aree naturali, per via delle loro pratiche di sussistenza; queste aree naturali allora spesso racchiudono un'identità anche culturale (Phillips, 1998). È dunque importante considerare anche gli aspetti culturali legati al territorio e agli ambienti che noi definiamo naturali (che spesso, però, sono il frutto di trasformazioni dovute alle popolazioni locali che hanno vissuto, negli anni e nei secoli, quei territori). Dunque, anche gli aspetti legati alla cultura del territorio e al paesaggio, come frutto della compresenza tra uomo e natura nel tempo, costituiscono l'oggetto e una fonte di attrazione per il turista 4L.

Se la componente educativa può essere quella più difficilmente ritrovabile tra le richieste esplicite dei turisti in generale, nel turismo 4L l'apprendimento è invece una dimensione fondamentale. La dimensione dell'evasione può essere rappresentata dal trovarsi in un luogo diverso e contrapposto alla routine quotidiana; l'ambiente naturale tipico di una destinazione che si rivolge a un turismo nature-based enfatizza l'elemento dell'evasione, che è ancor più rilevante se l'offerta si caratterizza per la sua autenticità e permette al turista di evadere dalla quotidianità e scoprire luoghi diversi. Dwyer (2008) evidenzia tra i trend di tipo sociale il self-improvement: le persone sono sempre più interessate a scoprire, a vivere delle esperienze e a imparare cose nuove relative alla destinazione che visitano. Esse sono sempre più interessate a migliorarsi, acquisire qualcosa di nuovo, imparare, sviluppare alcune capacità, apprezzare la cultura delle destinazioni. Si afferma pertanto la tendenza globale di "viaggiare per imparare qualcosa". Per un numero crescente di turisti, dunque, la vacanza non è più una forma di semplice consumo, ma diventa un investimento in sé stessi. Di conseguenza, la barriera tra leisure e educazione si affievolisce, fino a scomparire.

Come risultato di questi recenti sviluppi, il turismo e i momenti ricreativi diventano un veicolo importante con il quale le persone possono acquisire conoscenze, sviluppare idee e costruire nuove visioni per loro stessi e la loro società. Alla luce di quanto sino qui evidenziato, appare evidente l'importanza delle risorse territoriali (in tutte le sue accezioni) in termini di attrattività turistica della destinazione. Allo stesso tempo, tuttavia, lo sviluppo turistico (che beneficia proprio di queste risorse) può avere impatti negativi sulle aree naturali qualora esso non sia adeguatamente pianificato e gestito (Schelhaas, 2007). Da un punto di vista scientifico, la letteratura sottolinea opportunità e criticità di questo sviluppo, ma evidenzia altresì un gap in merito a politiche e strumenti di gestione di forme di turismo riconducibili all'ecoturismo piuttosto che al turismo 4L (Fennell e Dowling, 2003). Il crescente interesse manifestato dai turisti per la ricerca di esperienze che coinvolgano anche l'aspetto cognitivo attraverso l'immersione in nuove idee, luoghi e attività (Lončarić *et al.*, 2018) può rappresentare un'opportunità per i territori per adottare nuove azioni e strumenti per gestire queste forme di turismo. Il riferimento è all'interpretazione ambientale, ossia ad attività educative che vengono effettuate in aree naturali o protette per trasmettere ai visitatori il significato e l'importanza di ciò che essi stanno vivendo e dell'ambiente circostante in cui essi si trovano (Skanavis e Giannoulis, 2009). Quando si parla di interpretazione ambientale si fa riferimento a tutti quegli strumenti comunicativi (come indicazioni segnaletiche, brochures, opuscoli, visite guidate, pannelli, esposizioni, e centri per i visitatori), che stimolano l'interesse, promuovono la conoscenza, guidano i visitatori nell'adottare un comportamento appropriato per un turismo sostenibile, considerando comunque l'aspetto ricreativo dell'esperienza di visita e cercando

di aumentare la soddisfazione tratta da questa (Moscardo *et al.*, 2004). Ci si riferisce anche ad attività educative che fanno emergere significati e arricchiscono le esperienze dei visitatori, come può essere ad esempio una visita guidata effettuata da un esperto.

Come sostiene Ham (1992) l'interpretazione è semplicemente un approccio alla comunicazione. L'interpretazione ambientale comporta la traduzione del linguaggio tecnico delle scienze naturali in termini e idee che le persone, non esperti naturalisti, possano facilmente comprendere. E ciò viene svolto in modo tale da far divertire e intrattenere le persone, in modo da farle interessare. Secondo Moscardo (1998), l'interpretazione è "qualsiasi attività che si pone il compito di spiegare alle persone il significato di un oggetto, di una cultura o di un luogo". Le sue tre funzioni fondamentali sono migliorare e arricchire l'esperienza di visita, aumentare la conoscenza e la comprensione da parte dei visitatori ed essere di supporto nella protezione o conservazione di luoghi o culture.

L'interpretazione ambientale coinvolge i turisti educandoli in merito alle conseguenze delle loro azioni e li incoraggia a impegnarsi in comportamenti necessari per la sostenibilità dell'ambiente (Skanavis e Giannoulis, 2009). Le aree protette sono un emblematico esempio di risorse naturali che forniscono opportunità di apprendimento "non-formal". Attraverso l'interpretazione ambientale si incoraggiano i visitatori a porsi delle domande sui loro valori, sulle loro abitudini e sui loro comportamenti riguardanti questioni controverse e considerando, a loro volta, essi stessi educatori attivi alla conservazione (Skanavis e Giannoulis, 2009).

L'interpretazione ambientale, in questo senso, può essere una strategia utile per favorire un comportamento virtuoso e rispettoso dell'ambiente da parte dei visitatori e, dunque, una modalità efficace per accompagnare la gestione dello sviluppo turistico di un'area naturale in maniera sostenibile (Moscardo, 1998). Si tratta di una forma di comunicazione che viene spesso utilizzata assieme ad altre strategie di visitor management.

3. Metodo della ricerca

3.1 Area territoriale oggetto di indagine

L'area territoriale eletta ai fini della ricerca è la Val di Tovel. Questa valle si estende (per circa 17 chilometri) all'interno del Parco Naturale Adamello Brenta (PNAB) che, ad oggi, è l'area protetta più vasta del Trentino. L'elemento di maggiore attrazione della Val di Tovel è l'omonimo lago. Il Lago di Tovel è una delle principali motivazioni che hanno portato alla nascita dell'area protetta. In passato il lago è divenuto famoso in tutto il mondo per la colorazione rossastra che assumeva durante un preciso periodo dell'anno. Fino al 1964, infatti, nei primi mesi estivi di ogni anno il lago era soggetto ad un fenomeno di arrossamento, unico al mondo per l'intensità di colore ed estensione, dovuta alla presenza di una specifica alga. Ad oggi, sebbene quest'alga sia ancora presente, la colorazione non è più visibile poiché presente in concentrazione minore (PNAB, 2018).

Dal 1980 il lago di Tovel è stato tutelato come zona umida di importanza internazionale dallo Stato, secondo la Convenzione di Ramsar.

Grazie alle specificità di questo territorio, la Val di Tovel è da sempre una meta turistica molto rilevante all'interno del Parco Naturale Adamello Brenta. Al fine di regolamentare l'accesso di flussi visitatori all'interno di quest'area, dai primi anni del 2000 sono state introdotte alcune limitazioni. L'anno 2017 ha visto la quattordicesima stagione estiva per la Mobilità Sostenibile elaborata dal Parco in accordo con l'amministrazione comunale. La relazione conclusiva del Progetto Mobilità Sostenibile 2017 illustra gli accessi dei veicoli paganti da giugno a ottobre 2017 (Povinelli, 2017). Dal confronto con l'anno precedente (il 2016 risultava quello con il più alto numero di presenze) emerge un ulteriore crescita (+ 38%) degli accessi. Si conferma pertanto l'interesse dei turisti per questo tipo di destinazioni, ma anche la necessità di adottare strumenti manageriali in grado di garantire la salvaguardia delle aree naturali stante il continuo incremento di presenze turistiche e l'affermarsi di seri problemi ambientali e di protezione (Chini, 2017). La

crescita di notorietà della Val di Tovel è dipesa sia dalla forte promozione effettuata dall'ente turistico locale, sia dalla pubblicità attraverso social networks e le testate italiane principali. Questo afflusso in continua crescita che interessa anche i mesi autunnali, è visto positivamente da un punto di vista turistico, ma insostenibile e fragile da un punto di vista eco-sistemico.

Lo scenario sin qui descritto rende evidente pertanto la necessità di introdurre e rafforzare strumenti manageriali in grado di coniugare lo sviluppo turistico con i principi della sostenibilità. Come già evidenziato in apertura del lavoro la scelta della Val di Tovel quale area in cui condurre la ricerca, è dipesa dalle specificità che la contraddistinguono. Da un punto di vista metodologico, pertanto, la Val di Tovel rappresenta un'area di studio adatta ad indagare i temi oggetto di ricerca verificando l'efficacia di strumenti e scelte di interpretazione ambientale.

3.2 Popolazione indagata, focus della ricerca e analisi dei dati

Il primo step affrontato dalla ricerca è stata la ricostruzione dei profili di visitatori che si recano in Val di Tovel. Tale analisi ha verificato due importanti aspetti: 1) la corrispondenza della popolazione indagata con il profilo del turista 4L (e quindi l'attendibilità dei risultati ottenuti), 2) il livello di consapevolezza e sensibilità dei visitatori verso gli impatti da essi generati sul territorio. Da tali evidenze è stato possibile comprendere se e come scelte di interpretazione ambientale potrebbero alimentare, piuttosto che consolidare, le aspettative latenti e manifeste dei turisti 4L.

L'indagine è stata condotta nell'estate 2018 (15 luglio - 30 agosto) attraverso la somministrazione di questionari ad un campione casuale di visitatori. I questionari sono stati auto-compilati attraverso l'utilizzo di un tablet posizionato in zona ben visibile all'inizio del percorso espositivo. Non avendo a disposizione una rete Wi-Fi, è stato utilizzato il programma QuickTapSurvey in modalità offline e successivamente è stata effettuata una sincronizzazione dei dati.

Il questionario è stato proposto solo in italiano, poiché osservando le presenze durante le stagioni estive degli anni precedenti, la maggior parte dei visitatori proveniva dall'Italia. Le domande sono state definite a seguito dell'analisi della letteratura (Tab. 1) e delle sollecitazioni emerse da un workshop organizzato presso il Museo delle Scienze (a Trento) in cui si sono discusse possibili soluzioni finalizzate alla salvaguardia e valorizzazione delle aree naturali.

I principali focus del questionario sono quattro così articolati:

1. Awareness: analisi della consapevolezza del visitatore riguardo al suo impatto sul territorio;
2. Care-off: analisi della sensibilità del visitatore in merito alle tematiche ambientali e alle pratiche sostenibili;
3. Educazione e interpretazione ambientale: valutazione degli strumenti e delle logiche attualmente presenti sul territorio e di eventuali potenziamenti.
4. Dati sociodemografici: informazioni necessarie per la profilazione degli intervistati e successiva identificazione del target.

Tab. 1: Focus di analisi e principali riferimenti a letteratura e documentazione consultata

Focus	Bibliografia	Sitografia e documentazione online
Awareness	Mustoni et al. (2012); Wolter (2014); Kennell (2016); World Travel & Tourism Council (2018).	Balotta (2017), Nicoletti (2018), Progetto Life Tovel (2018)
Care-off	Minciu et al. (2012); Istat (2014 e 2017); PAT, TSM (2014).	Carillo (2014); Repubblica.it. (2016).
Educazione e interpretazione ambientale	Giacomini, Romani (2002); Zerbi, Minidio (2003); Skanavis, Giannoulis (2009); Calzati (2016); Kocher (2017).	Learning for Sustainability (2018); Sustainabletourism.net. (2018).

Complessivamente sono stati compilati 764 questionari, dei quali 391 sono stati ritenuti completi.

Al fine di cogliere anche le opinioni degli operatori coinvolti nella gestione di questa area naturale, un questionario analogo a quello adottato per i visitatori è stato somministrato a 22 lavoratori stagionali presenti in Val di Tovel. Essi sono operatori del Parco ed esperti del MuSe. Questi operatori sono stati considerati come rappresentanza della comunità locale.

A questi dati, si sono aggiunti anche quelli ottenuti dalle interviste con 86 partecipanti all'8a Conferenza Internazionale dei Geoparchi Mondiali UNESCO, tenutasi dal'8 al 14 settembre 2018 a Madonna di Campiglio (Trentino). Questi esperti hanno potuto visitare la Val di Tovel durante la loro permanenza e successivamente hanno risposto ad alcune domande precedentemente estratte dall'elaborato iniziale.

I dati così raccolti sono stati analizzati come segue: 1) analisi di statistica descrittiva sui questionari somministrati ai visitatori; 2) analisi delle corrispondenze multiple (ACM) al fine di ricostruirne il profilo; 3) analisi dei cluster gerarchica condotta con criterio di aggregazione di Ward sulla sezione relativa ai quesiti con richiesta di valutazione (dimensione awareness) per confronto dati tra operatori e visitatori.

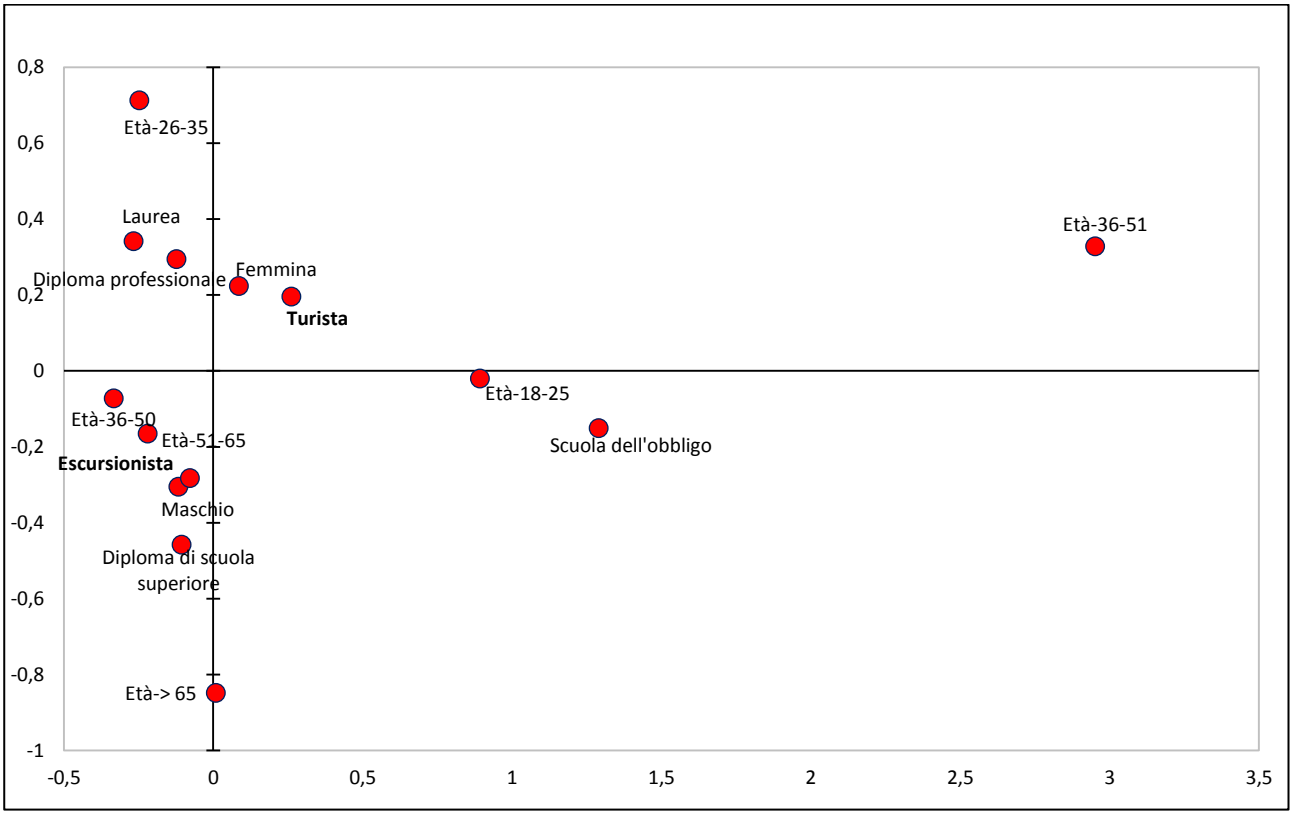
Dopo aver illustrato le principali caratteristiche del profilo dei rispondenti, il paragrafo 5 presenta i principali risultati della ricerca.

4. Il profilo degli intervistati

Il profilo degli intervistati è stato ottenuto elaborando i 391 questionari completi su 764 totali. Si può osservare un campione abbastanza bilanciato per quanto riguarda il genere, si nota una prevalenza femminile del 57,7% rispetto ai maschi 42,3%. In merito all'età, la distribuzione è omogenea ad eccezione della fascia d'età over 65 che figura solo per un 7%. Questo risultato è compatibile con la tipologia di attività che possono essere svolte in Val di Tovel e che portano ad attività fisica di difficoltà differenti. La fascia più numerosa, il 32% degli intervistati, è quella tra i 36 e i 50 anni che comprende anche la moda. Questi dati sono in linea con le caratteristiche degli intervistati nel Parco Naturale Adamello Brenta nell'estate 2016 durante un sondaggio sull'indice di gradimento delle case del Parco (Comunicazione Personale, 2018).

Il campione copre percorsi formativi diversi: dalla scuola dell'obbligo alla laurea o diploma di laurea. Quest'ultima opzione è stata scelta dal 38,6% degli intervistati, a seguire il diploma di scuola media superiore (34,2%), la qualifica o diploma professionale (14,6%) e la scuola dell'obbligo (12,6%). Dai 391 questionari completi sono stati esclusi i 15 compilati da residenti nel comune di Ville d'Anaunia. Quindi si è potuto evidenziare attraverso la ACM alcune caratteristiche che identificano le due tipologie di fruitori del Parco: i turisti e gli escursionisti (Fig. 1). Essi presentano alcuni tratti caratterizzanti e, allo stesso tempo, distintivi. A differenza dei turisti, risulta evidente, come gli escursionisti rientrino nelle fasce d'età più alte.

Fig. 1: Profilo del visitatore



Fonte: ns. elaborazione

5. Risultati della ricerca

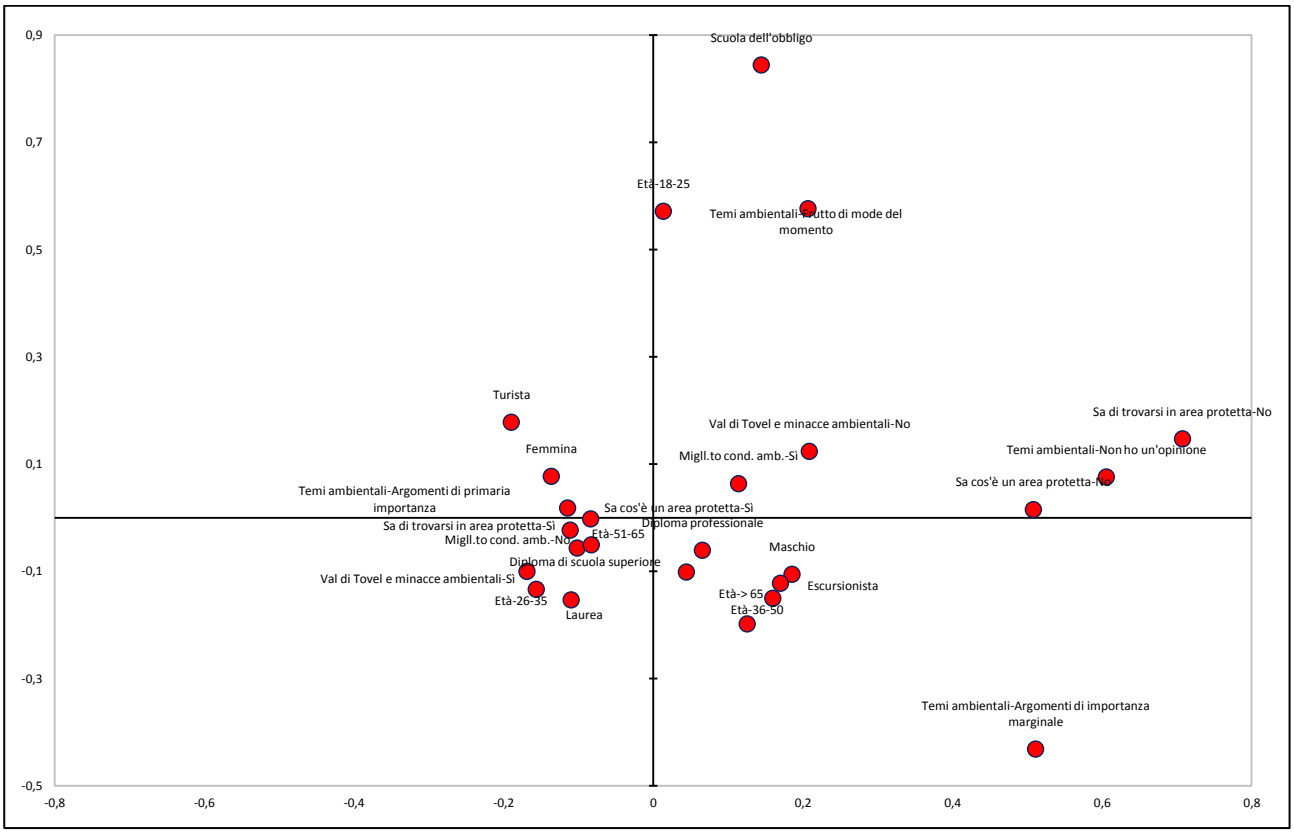
5.1 Dimensione awareness e care-off dei visitatori

L'analisi dei dati evidenzia come i visitatori non abbiano una forte consapevolezza dell'esposizione della Valle a minacce ambientali, infatti il 44,8% degli intervistati non riscontra alcun pericolo ambientale per la Val di Tovel.

Lo stesso quesito è stato posto anche agli operatori del Parco. In questo caso la consapevolezza è molto più elevata: il 90,5% ha risposto positivamente. Dunque, gli operatori risultano essere molto più coesi e, osservando la frequenza relativa, essi rispondono positivamente in misura doppia rispetto ai visitatori. Questa elevata conoscenza della fragilità della Val di Tovel può essere ricondotta al fatto che i rispondenti sono soprattutto giovani, residenti nei paesi limitrofi e che svolgono questo lavoro da più stagioni, avendo così una visione su più anni.

La ACM (Fig. 2) evidenza che la dimensione femminile è maggiormente consapevole della fragilità ambientale della Val di Tovel rispetto a quella maschile. Inoltre, si riscontrano differenze anche in base alla tipologia del visitatore: il turista è maggiormente consapevole di trovarsi in un'area protetta e in una realtà esposta a minacce ambientali. Per di più è importante sottolineare come il visitatore di sesso femminile sia più propenso a non credere in futuri miglioramenti delle condizioni ambientali rispetto al sesso opposto.

Fig. 2: Analisi della dimensione della consapevolezza



Fonte: ns. elaborazione

Agli intervistati (216) che erano consapevoli della presenza di problemi ambientali anche in Val di Tovel è stato chiesto di valutare quanto alcuni fattori legati alla biodiversità fossero influenzati da una condotta non sostenibile da parte dell'uomo in Valle.

I risultati evidenziano come l'inquinamento del lago venga visto come principale conseguenza dell'impatto antropico in Val di Tovel, mentre altri problemi quali la modifica del comportamento di alcuni animali e l'impoverimento ed erosione del suolo non risultino così forti, a riprova della scarsa conoscenza degli effetti dell'uomo sulla fauna e sul suolo.

Un altro quesito che è stato posto riguarda la qualità ambientale della zona. Su 376 risposte il 45,5% ha valutato la qualità di questa Valle con il punteggio massimo (10). Ciò può far supporre un'assenza di percezione delle problematiche esistenti. La stessa domanda è stata posta agli operatori, i quali hanno scelto prevalentemente un punteggio positivo, ma meno elevato (7). Questo comporta da parte loro una maggiore preoccupazione e coscienza della situazione attuale della Valle.

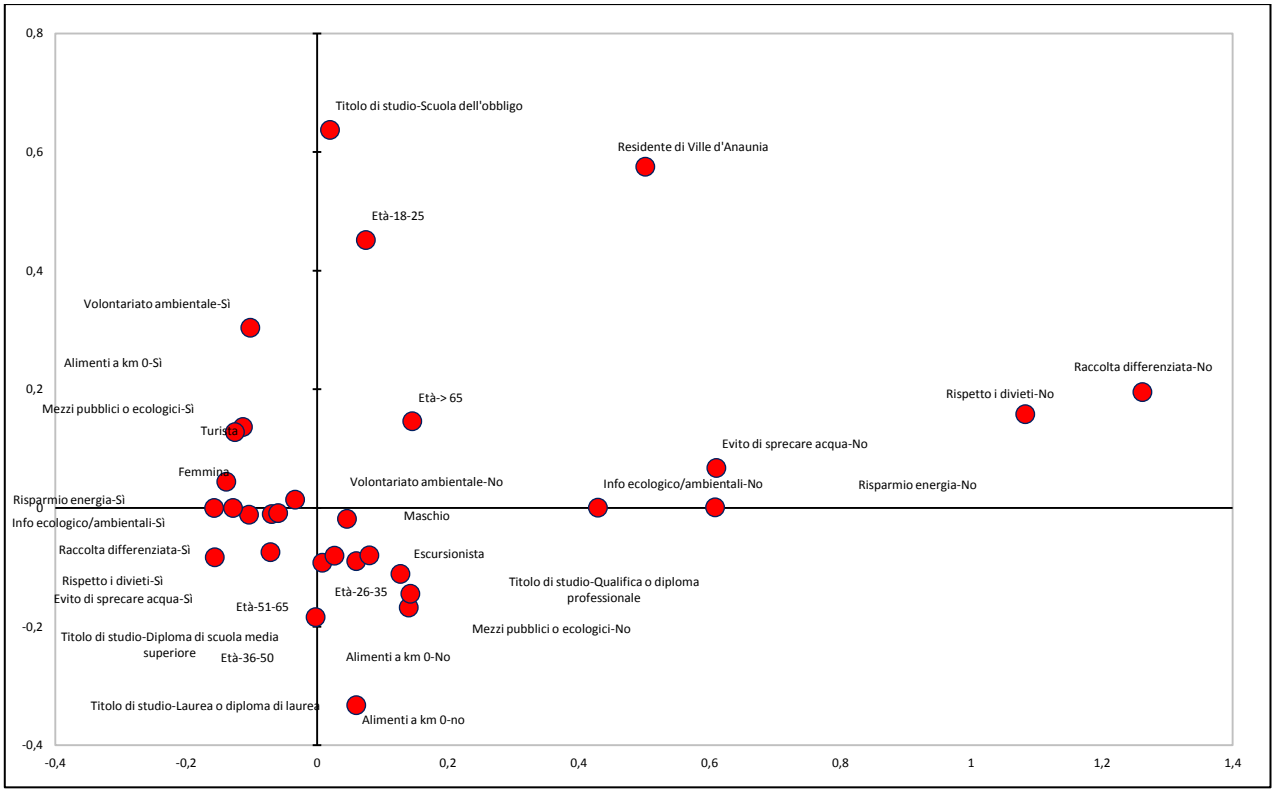
Infine, per quanto concerne l'analisi della consapevolezza del visitatore, si è analizzata la consapevolezza in merito alla pericolosità di quattro aspetti legati all'attrattività turistica della zona: l'aumento dell'inquinamento atmosferico e acustico, l'aumento della produzione e presenza di rifiuti, la frammentazione ambientale dovuta alla presenza di infrastrutture e la perdita dell'identità locale (usi, costumi e tradizioni). La valutazione è stata effettuata tramite punteggi da 1 a 10, ossia da un livello basso ad uno alto di pericolosità per l'attività turistica locale.

Il fenomeno maggiormente riconosciuto come pericolo, attribuendo un punteggio uguale a 10 dal 28,9% dei rispondenti, è quello dell'aumento della produzione e della presenza di rifiuti. A seguire viene riconosciuto, come minaccia, l'aumento di inquinamento acustico e atmosferico (26,6%), la frammentazione ambientale (19,1%) e la perdita di identità culturale (17,9%).

Per comprendere il livello di sensibilità, e di coinvolgimento fattivo di turisti ed escursionisti attraverso scelte e comportamenti coerenti con la sensibilità ambientale dichiarata, sono state poste

domande dicotomiche in merito ad abitudini quotidiane. I risultati dell'ACM (Fig. 3) evidenziano una maggior sensibilità laddove vi è maggiore consapevolezza delle condizioni ambientali. Anche in questo caso il genere femminile è più attento ed ecosostenibile rispetto al genere maschile, così come il turista rispetto all'escursionista. Si osservi, ad esempio, come la dimensione femminile faccia attenzione all'acquisto di alimenti a km0 così come alla ricerca di informazioni di carattere ecologico/ambientale. Al contrario la dimensione maschile risulta essere meno sensibile ad alcune azioni quali il volontariato ambientale o il risparmio energetico.

Fig. 3: Analisi della responsabilità

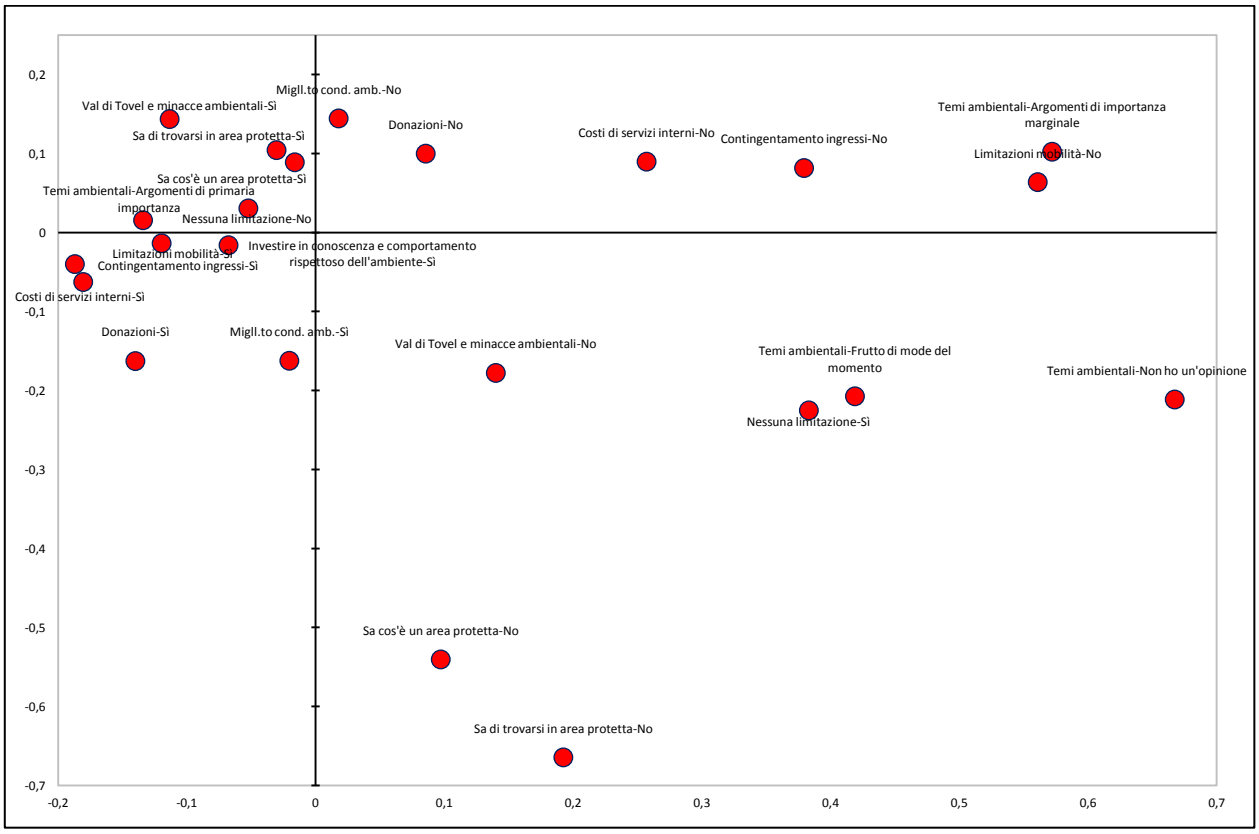


Fonte: ns. elaborazione

Sempre per quanto concerne lo studio della sensibilità del visitatore in merito a tematiche ambientali, sono stati proposti sei strumenti d'azione per ridurre l'impatto antropico in Val di Tovel. Il rispondente ha potuto replicare positivamente o negativamente a più scelte. Il 92,6% è favorevole ad accrescere le proprie conoscenze per assumere un comportamento più rispettoso dell'ambiente; l'81,8% del totale è propenso ad accettare limitazioni sulla mobilità. Al contrario, a livello monetario, il 61,9% non è bendisposto a partecipare economicamente tramite donazioni e il 41,6% ad accettare un aumento dei costi di servizi interni alla Valle. Il 12% del campione è contrario a qualsiasi tipologia di nuova limitazione.

La mappa di Figura 4 evidenzia come le persone consapevoli di trovarsi in un'area protetta e convinte che i temi ambientali siano argomenti di primaria importanza, siano maggiormente propense all'introduzione di strumenti e/o limitazioni per poter salvaguardare la Val di Tovel. Al contrario, coloro che non hanno captato la fragilità ambientale e considerano i temi ambientali di importanza marginale sono più restii all'incremento di strumenti di gestione della Valle come il contingentamento degli ingressi giornalieri così come l'aumento dei costi di servizi interni.

Fig. 4: Consapevolezza e comportamenti



Fonte: ns. elaborazione

5.2 Valutazione degli strumenti e delle logiche di educazione e interpretazione ambientale

La Val di Tovel è coordinata da giugno a ottobre dall'Ente Parco attraverso la gestione della mobilità. Da luglio a fine agosto ogni giorno vengono svolte gratuitamente attività di educazione e interpretazione ambientale da parte degli operatori del MuSe. Le tematiche trattate riguardano principalmente il lago e le motivazioni del suo arrossamento, ma anche altri argomenti quali, ad esempio, "i grandi carnivori". Le attività oltre ad essere promosse sui siti ufficiali del Parco Naturale Adamello Brenta e del MuSe, sono segnalate nel materiale promozionale della Valle e vengono indicate come comprese all'interno del prezzo del parcheggio.

Sebbene la promozione sia presente, la ricerca rileva che il 62,4% dei rispondenti non ne era a conoscenza. È importante ricordare che la maggior parte delle attività partono dalla Casa del Parco e quindi in un punto di concentrazione di visitatori. Rispetto al 37,6% di rispondenti che conoscevano le attività vi hanno partecipato il 26,9%.

La ricerca ha verificato se questi interventi degli esperti fossero utili ad accrescere la conoscenza del partecipante. Il 59,4% ha affermato che padroneggiava già le tematiche trattate. Questo fa supporre che ci possano essere stati visitatori che avevano già apprezzato il lago e letto la cartellonistica presente, ma anche persone che avevano una conoscenza approfondita della zona. Si può ipotizzare pertanto che una parte di visitatori, che non ha partecipato, avessero già un proprio bagaglio conoscitivo in riferimento ai temi trattati.

Rispetto alla cartellonistica, si è voluto analizzare se essa venisse letta dagli ospiti presenti in Valle. I dati mostrano una percentuale elevata di visitatori (82,9%) che ha letto la cartellonistica presente, dove vengono indicate le regole per un buon rispetto dell'ambiente. Questo strumento di educazione ambientale è un punto di partenza per accrescere la consapevolezza nel visitatore sia in merito all'aumento di conoscenza della fragilità del territorio che riguarda la natura della Valle, sia rispetto al fatto che si trova all'interno di un Parco Naturale.

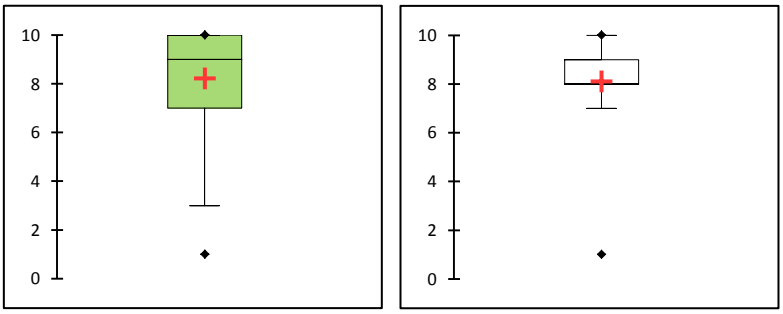
Infine, è stato chiesto all'intervistato di scegliere le modalità, a suo parere più opportune, al fine di rendere il comportamento dei visitatori maggiormente rispettoso dell'ambiente; lo stesso quesito è stato posto anche agli operatori PNAB e MuSe.

Secondo i visitatori un coinvolgimento diretto nell'attività di ricerca scientifica del Parco risulta essere la strategia migliore (71,4%), a seguire le altre modalità: il 66,5% è favorevole all'aumento delle attività organizzate, ma anche all'introduzione di metodi meno innovativi come l'incremento della sorveglianza (67,8%) e/o della cartellonistica (65,2%).

Per quanto concerne l'opinione dei lavoratori stagionali, sono soprattutto le tecniche più severe ad essere quelle maggiormente scelte, come la limitazione del numero di accessi giornalieri (95,5%) e l'aumento della cartellonistica e della segnaletica (95,5%). Rispetto ai visitatori, "il coinvolgimento diretto in attività di ricerca scientifica del Parco" risulta l'opzione meno scelta, con una percentuale del 63,6%. Questi risultati possono essere migliorati facendo svolgere le attività innanzitutto agli operatori, che a loro volta possono poi promuovere la loro esperienza ai visitatori. Un coinvolgimento diretto di alcuni di essi nelle attività, potrebbe accrescere l'aspettativa in queste modalità di educazione ambientale.

Confrontando visitatori e operatori in merito alle risposte date alla domanda "Quanto ritiene che il comportamento del visitatore odierno possa influire sulla salvaguardia della Val di Tovel?" si possono osservare delle differenze (Fig. 5). La deviazione standard pari a 2,16 individua una maggiore variabilità delle risposte tra i dati provenienti dal questionario dei visitatori. In questo caso il primo quartile corrisponde a 7 e il terzo a 10. Nel caso degli operatori invece, si evidenzia una variabilità minore con deviazione standard pari a 1,92; primo e terzo quartile hanno rispettivamente i valori di 8 e 9. Inoltre, osservando la mediana, nel primo caso essa si posiziona a 9 (dunque il 50% delle osservazioni rientrano al di sopra di questo valore), mentre nel secondo caso si abbassa a livello 8, quindi gli operatori ritengono meno robusto il collegamento tra il comportamento del visitatore odierno e la salvaguardia futura della Val di Tovel. Nel caso degli operatori, la mediana e la media coincidono con il primo quartile. Si osserva quindi un'asimmetria negativa nel primo box plot, ossia la media 8,22 risulta essere inferiore alla mediana (9). Mentre nel secondo box plot si evidenzia un'asimmetria positiva dove la media uguale a 8,09 che supera il valore della mediana pari a 8.

Fig. 5: Box plot visitatore (a sinistra) e box plot operatore (a destra)



Nota: L'analisi si riferisce alla domanda "Quanto ritiene che il comportamento del visitatore odierno possa influire sulla salvaguardia della Val di Tovel?"

Fonte: ns. elaborazione

Dall'analisi dei cluster gerarchica condotta con criterio di aggregazione di Ward, sulla sezione relativa ai quesiti con richiesta di valutazione su scala da 1 a 10, si può osservare la presenza di tre distinti gruppi di rispondenti come emerge dal dendrogramma (Fig. 6) e, in maniera più chiara, dal grafico del profilo delle classi (Fig. 7).

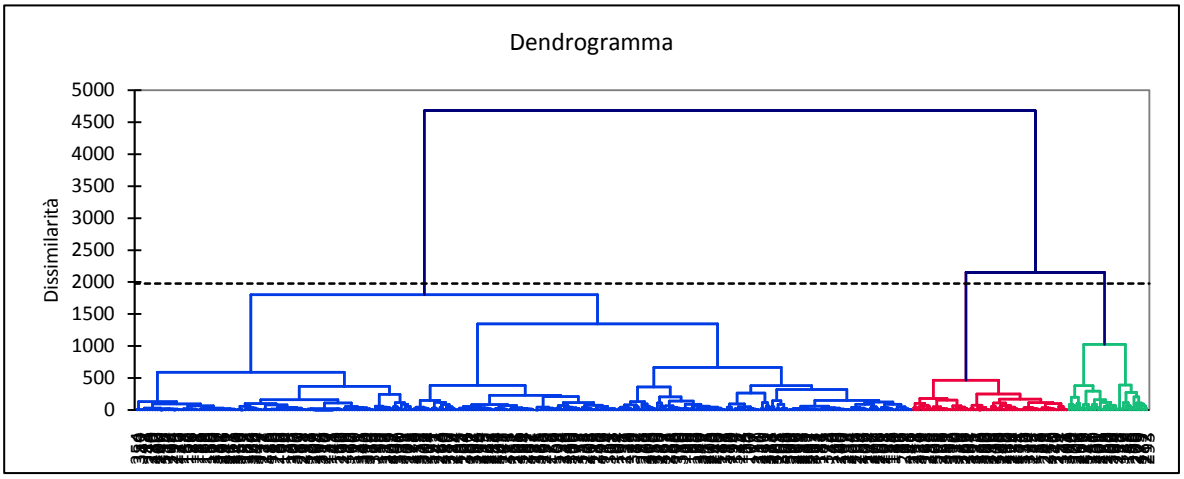
I tre profili individuati sono stati denominati come segue: 1) High evaluation cluster; 2) Intermediate evaluation cluster; 3) Low evaluation cluster.

Queste tre classi sono composte da un numero diverso di soggetti: high evaluation cluster è la più numerosa con 300 rispondenti. A seguire intermediate evaluation cluster (60) e low evaluation

cluster (31). All'interno di ogni profilo sono presenti gruppi omogenei con caratteristiche proprie:

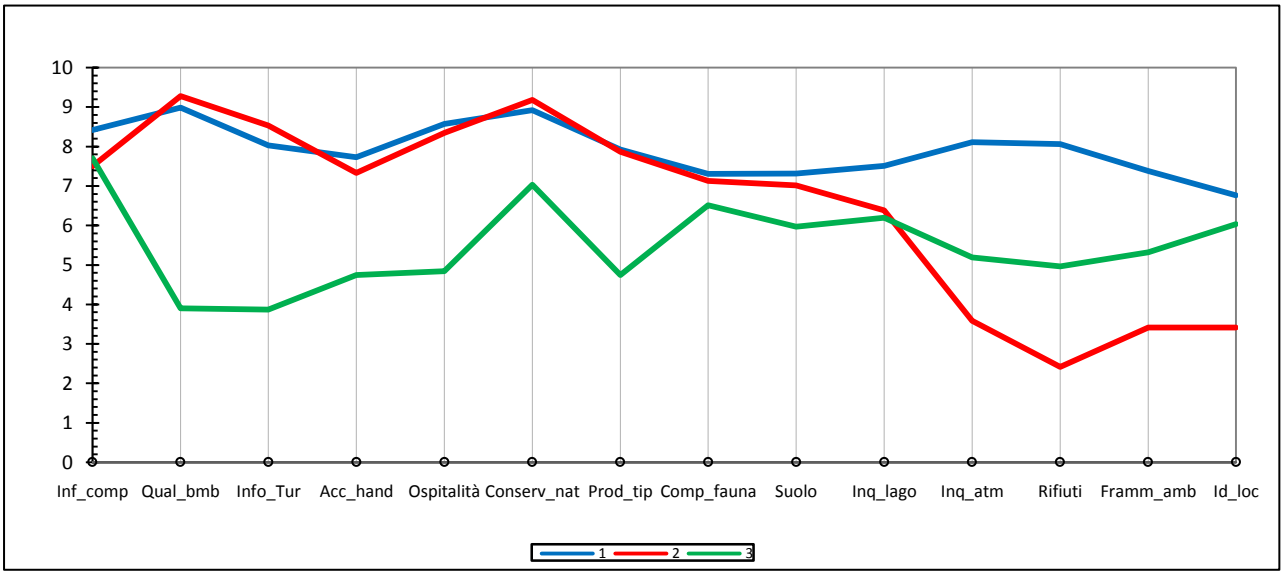
- La prima classe "high evaluation cluster" è costituita da coloro che presentano valutazioni decisamente positive in merito a tutti gli item considerati ossia i servizi presenti in Valle come ospitalità e cordialità degli operatori in loco, accessibilità per i portatori di handicap o distribuzione di informazioni turistiche e la pericolosità di minacce sulla biodiversità e sull'attrattività turistica causate dalla presenza dell'uomo in Val di Tovel come l'inquinamento del lago o la frammentazione ambientale dovuta alla presenza di infrastrutture. In questo caso, si evidenzia una valutazione media di 7,9.
- La seconda classe "intermediate evaluation cluster" segue un andamento analogo alla prima classe alle prime voci e successivamente si distanzia fortemente quando vengono valutate caratteristiche naturalistico/ambientali. Questo scostamento viene evidenziato dalla valutazione media che risulta essere di 6,5.
- La terza classe "low evaluation cluster" presenta valutazioni decisamente basse, sebbene rimangano superiori a quelle dell'intermediate evaluation cluster per quanto concerne i voti sulla pericolosità di alcuni elementi all'attrattività turistica della zona. Quest'ultima classe mostra una valutazione media di 5,5.

Fig. 6: Risultanze dell'analisi dei cluster



Fonte: ns. elaborazione

Fig. 7: Profilo delle classi



Fonte: ns. elaborazione

6. Logiche e strumenti di educazione e di interpretazione ambientale: attività esistenti e possibili sviluppi

In Val di Tovel vengono svolte attività guidate dagli esperti del MuSe in collaborazione con il Parco Naturale Adamello Brenta. Oltre ad escursioni durante la stagione estiva, durante l'anno scolastico vengono svolte anche attività di educazione ambientale rivolte agli studenti. In questo caso viene spesso utilizzata come luogo di educazione anche la Stazione Limnologica di proprietà del Comune di Tuenno e utilizzata dagli operatori MuSe per scopi scientifici e didattici (Muse.it, 2018) e la Casa del Parco "Lago Rosso", un centro visitatori con un percorso tematico riguardante la perdita della colorazione del lago, una sala adibita a filmati, e un punto vendita dei gadget del Parco. Tutte le attività hanno lo scopo di far vivere emotivamente la Val di Tovel: non vengono svolte delle lezioni, ma le tematiche vengono reinterpretate. Siamo di fatto nell'ambito dell'interpretazione ambientale.

A titolo esplicativo si può descrivere un'attività, ad oggi non più realizzata, ovvero il Teatro Scientifico "Che fine ha fatto Jack Black?". In questo caso, elementi di curiosità e scienza si mescolano e si crea una storia nella quale è presente un forte coinvolgimento dei bambini che apprendono divertendosi. Il palcoscenico è un percorso che si snoda lungo il sentiero "Lago di Tovel" fino alla Stazione Limnologica del MuSe. L'obiettivo è quello di presentare il lago di Tovel e il fenomeno dell'arrossamento in maniera stimolante e che susciti attrazione per la limnologia, ovvero la scienza che studia i laghi e i suoi organismi (Comunicazione personale, agosto 2018). Durante la stagione estiva vengono svolte numerose attività sempre legate all'interpretazione ambientale, quindi con l'obiettivo di indirizzare il visitatore a una maggiore sensibilità ambientale e al cambiamento del proprio comportamento per renderlo maggiormente sostenibile (Comunicazione personale, agosto 2018).

Nelle sezioni che seguono si illustrano alcune possibili scelte operative che potrebbero essere adottate in Val di Tovel al fine di consolidare quanto già intrapreso sino ad oggi in tema di educazione ambientale. Le proposte fanno riferimenti a best practice e/o iniziative già sperimentate in altri territori (Tab. 2) che potrebbero trovare applicazione anche nel territorio della Valle di Tovel, rafforzando la capacità di questo territorio di rispondere agli interessi delle classi di turisti maggiormente coinvolti e interessanti a pratiche di turismo 4L (high evaluation cluster) e sollecitando i visitatori con interesse ancora poco sviluppato.

Tab. 2: Proposte di educazione e interpretazione ambientale per la Valle di Tove e best practice di riferimento

Proposte di educazione e interpretazione ambientale	Best practice e/o esperienze di riferimento
Esperto parco per un giorno	Australia (Ballantyne e Packer, 2005) e aree dei grandi parchi in America e Africa
Calcola il tuo footprint	*Big Foot* Museum of Applied Arts and Sciences, Sidney
Adotta una specie del parco	Adotta un peluche - sostieni WWF Italia

Fonte: ns. elaborazione

6.1 "Esperto Parco per un giorno: il monitoraggio faunistico" un'evoluzione dell'attività "In ricerca col Parco"

Durante la stagione estiva 2018 è stata introdotta una nuova attività da parte del Parco Naturale Adamello Brenta con titolo "In ricerca col Parco". Tutte le uscite seguono lo stesso schema (PNAB, 2018), ma gli esperti si concentrano su argomenti differenti. Durante i loro interventi, infatti, le tematiche sono state scelte in base alle peculiarità del territorio. L'esperienza si articola come segue: viene svolta una semplice camminata e durante il tragitto i partecipanti vengono direttamente coinvolti in diverse attività, incluso il monitoraggio ambientale. Ad ogni turista, viene consegnato un kit da ricercatore nel quale sono presenti: mappa del transetto (se esistente), guanti in lattice, taccuino, righello e matita per poter annotare i ritrovamenti, tutto ciò sotto la guida di un operatore dell'Area Ricerca Scientifica e Educazione Ambientale del Parco Naturale Adamello Brenta. L'attività di monitoraggio svolta dai partecipanti è una simulazione semplificata dei censimenti

della fauna che regolarmente svolgono gli operatori del Parco. Durante la mattinata, ci si occupa di monitoraggio faunistico mirato, ma qualora si presentasse l'occasione di avvistamenti o l'individuazione di una specie di particolare interesse si svolgerebbe anche un monitoraggio faunistico occasionale con i turisti.

Partendo dall'attività "In ricerca col Parco", che ha riscosso successo durante la stagione estiva 2018, la proposta che scaturisce nell'ambito delle attività di educazione ambientale è l'iniziativa "Esperto Parco per un giorno: il monitoraggio faunistico".

L'idea nasce dal fatto che gli incontri con la natura, soprattutto se coinvolgono animali selvatici, possono produrre un forte impatto emotivo sui partecipanti, i quali ripensano alle loro abitudini e comportamenti in relazione ai problemi ambientali. Due studi australiani, che avvalorano questa tesi (Ballantyne e Packer, 2005), hanno dimostrato che i visitatori alla fine dell'attività, non solo avevano accresciuto le proprie conoscenze, ma avevano anche confermato di aver intrapreso specifici comportamenti sostenibili come la rimozione dei rifiuti dalle spiagge, fino a sei mesi dopo l'esperienza.

La proposta di educazione ambientale "Esperto Parco per un giorno: il monitoraggio faunistico" è pensata per un target di soli adulti. Un gruppo composto da massimo 5 turisti, che affianca i due operatori del Parco lungo un transetto, stabilito precedentemente da questi ultimi. La partenza è all'alba, durante il tragitto con l'auto dell'Ente Parco vengono indicate le principali regole del monitoraggio e vengono date le informazioni utili. Una volta giunti sul transetto vengono catalogati i ritrovamenti con apposite sigle su una tabella preimpostata e a seguito della conferma da parte dell'operatore. Il monitoraggio coinvolge i 5 sensi: non si tratta solo di monitoraggio visivo, ma anche acustico. Inoltre, trovandosi in zone poco turistiche e durante le prime ore del mattino, è più probabile svolgere anche attività di wildlife watching. L'attività è pensata per una durata di 4/5 ore.

Questa tipologia di offerta turistica, soprattutto il wildlife watching è in continua crescita. Secondo l'Adventure Tourism Market Report della George Washington University c'è stato un incremento di richiesta per l'adventure tourism del 65% superando i 300 miliardi di dollari di fatturato annuale. Questo interessamento e sensibilizzazione al mondo animale è un grande aiuto per la conservazione della biodiversità e per la salvaguardia di specie in via di estinzione (Turner Seydel, 2016).

6.2 Centro visitatori: calcola il tuo Footprint. Best practice "Big Foot" del Museum of Applied Arts & Sciences (Sydney)

Questa proposta scaturisce dalla consapevolezza che le strutture presenti in un'area protetta come i musei e i centri scientifici sono realtà dove poter svolgere attività di educazione informale. La loro posizione privilegiata li rende luoghi ideali per affrontare le tematiche legate ai principali problemi ambientali (Ballantyne and Packer, 2005).

Ad oggi, i musei e i centri visitatori non vengono più considerati unicamente come punti di esposizione, ma producono delle esperienze che incoraggiano i visitatori ad esplorare non solo gli artefatti storici e i fenomeni scientifici, ma anche i problemi sociali attuali.

Le mostre riguardanti i problemi ambientali (Ballantyne and Packer, 2005) portano il visitatore a pensare in maniera critica, a prendere decisioni, a interagire con gli altri fruitori e ad esplorare i propri sentimenti riguardo a determinate problematiche. Questo è il caso del Museo di Scienze e Arti Applicate che si trova a Sydney. All'interno è presente un'esposizione permanente dal titolo "EcoLogic: creating a sustainable future exhibition". Questa mostra è stata creata con l'intento di studiare i cambiamenti dei valori e dei comportamenti della società nei confronti dell'ambiente (Ballantyne and Packer, 2005). EcoLogic considera uno dei temi globali ad oggi più critici: il cambiamento climatico. Attraverso oggetti, opere, video e strumenti interattivi si spiegano le problematiche globali e sfidano il visitatore ad iniziare ad intraprendere scelte maggiormente sostenibili nella singola vita quotidiana (Museum of Applied Arts and Sciences, 2018).

L'elemento che maggiormente influisce sul cambiamento dei comportamenti del visitatore è la presenza del Big Foot, un touch-screen con il quale, attraverso un programma interattivo, ogni

visitatore può calcolare la propria impronta ecologica sull'ambiente. Viene definito come un computer game dove al giocatore vengono poste 15 domande legate alla propria quotidianità, ossia alle proprie abitudini alimentari, alla tipologia di abitazione, ai mezzi di trasporto che utilizza e ai dispositivi/elettrodomestici che usa nella sua casa e in ufficio. Il programma successivamente elabora il "footprint" che illustra quanto suolo, acqua ed energia il giocatore usi annualmente (Museum of Applied Arts and Sciences, 2018).

Questa esposizione di grande successo potrebbe essere riprodotta all'interno della Casa del Parco in Val di Tovel che verrà ricostruita e ammodernata entro il 2021.

I risultati ottenuti dovrebbero suscitare emozioni e riflessioni per apportare miglioramenti nei comportamenti. Dunque, al risultato della misura dell'impronta ecologica ottenuta dalle risposte date, occorre associare una foto che mostri le possibili conseguenze delle proprie azioni, come ad esempio un animale marino soffocato dalla presenza di plastica nel suo habitat. Al contrario, se l'impronta ecologica ottenuta indica un valore molto basso, si dovrebbe mostrare una foto che susciti felicità e contentezza.

Infine, occorre considerare anche la possibilità di introdurre un feedback sociale, ossia il risultato finale comparato con la risposta media così da accrescere la voglia di miglioramento del proprio atteggiamento come ampiamente dimostrato da un punto di vista psicologico.

Con riferimento al caso di studio si ritiene che adattando e aggiungendo alcuni elementi, si ritiene molto efficace la realizzazione di un percorso guidato legato ai cambiamenti climatici e alla possibilità di calcolare il proprio impatto ambientale in maniera semplice e intuitiva presso la Casa del Parco "Lago Rosso".

6.3 Adotta una specie del Parco. Best Practice "Adotta con un peluche" di WWF

In Val di Tovel, così come in altri territori e aree protette, gli animali devono affrontare enormi sfide per far fronte alle minacce dirette e indirette dell'uomo e tra queste anche quelle legate alle attività turistiche.

La salvaguardia della biodiversità e dell'ambiente è principalmente compito dei governi e delle istituzioni, ma anche l'uomo nel suo piccolo può apportare un importante contributo. Ne sono esempi le numerose campagne di raccolta fondi per la realizzazione di ricerche e studi scientifici in grado di analizzare le condizioni attuali di alcune specie della flora e della fauna (Brenna, 2015). Una campagna che ha riscosso particolare successo è "Adozioni WWF, adotta una specie in pericolo", che consente di scegliere una o più delle 17 specie di animali a rischio estinzione (Sostieni.wwf.it, 2018). L'adozione costa 50 euro e si riceve un peluche dell'animale scelto, una scheda sulla specie adottata, il certificato di adozione e una lettera di Fulco Pratesi, fondatore del WWF Italia. I proventi delle adozioni vengono poi destinati alla protezione della specie favorita.

In alcune valli del Parco Naturale Adamello Brenta è presente una Casa del Parco, ognuna delle quali ha un'esposizione che tratta un tema specifico, ma sempre legato alla conservazione della biodiversità e dove è presente un punto Bookshop, dove si possono acquistare i gadget ufficiali. Anche al Centro Visitatori in Val di Tovel è presente un Bookshop dove i visitatori posso acquistare un ricordo dell'escursione. Al fine di gestire il merchandising con un messaggio educativo si potrebbe prevedere di introdurre dei peluche, di medie dimensioni, delle principali specie che sono presenti nell'area del Parco e che spesso non sono nemmeno conosciute dal visitatore. È possibile spaziare tra specie di grandi carnivori come l'orso bruno, il lupo, la faina e la donnola agli ungulati.

Questa strategia si rivolge al target delle famiglie le quali spesso acquistano un souvenir per i bambini, ma ne trae vantaggi l'intero nucleo. Anche in questo caso si adotta una specie, ma tra quelle presenti nel Parco. Il costo è fisso e il profitto viene utilizzato per la ricerca scientifica svolta dagli Operatori del Parco in merito alle principali minacce ambientali come il cambiamento climatico. L'adozione di una specie del Parco consentirebbe al visitatore di:

- Ricevere una scheda tecnica sulla specie scelta, con la descrizione dell'animale, i suoi cambiamenti comportamentali a causa dell'uomo e delle minacce ambientali, il rischio di estinzione, le curiosità e le caratteristiche peculiari.

- Ottenere il certificato di adozione che ha validità un anno e che conferma l'acquisto.
- Ricevere la lettera del responsabile Ricerca Scientifica e Educazione Ambientale o del Direttore dell'Ente Parco.
- Rimanere aggiornati tramite newsletter dei risultati e dei progressi delle ricerche scientifiche in atto grazie al proprio contributo economico.
- Partecipare gratuitamente con la propria famiglia ad un'attività organizzata dal Parco che abbia come tema la specie scelta durante la stagione estiva successiva.

L'acquisto da parte del visitatore permetterebbe all'Ente Parco di:

- Conoscere maggiormente gli interessi dei visitatori della Valle poiché si possono osservare quali sono le specie maggiormente vendute e questo dato può essere un punto di partenza per la definizione delle attività della stagione dell'anno successivo.
- Creare fidelizzazione, poiché il turista è incentivato a ritornare per fruire dell'attività gratuita e per poter rinnovare l'adozione o adottare un'altra specie.
- Raccogliere fondi indispensabili per proseguire e iniziare ricerche scientifiche utili all'analisi della situazione attuale delle minacce ambientali all'interno del Parco e che compromettono la biodiversità, principale fattore d'attrazione per il turismo nel Parco.

7. Conclusioni

La ricerca ricostruisce i profili di visitatori che si recano in Val di Tovel (*high, intermediate e low evaluation cluster*) e ne analizza il livello di consapevolezza e sensibilità verso gli impatti da essi generati sul territorio. Tale analisi conferma la coerenza di questo segmento di domanda con i turisti interessati al turismo 4L e consente di indagare se e come scelte di valorizzare della dimensione educativa della vacanza e di interpretazione ambientale siano convincenti per rispondere alle aspettative latenti piuttosto che manifeste della domanda 4L.

La ricerca ha identificato azioni di rinforzo e suggerito nuovi strumenti di eduzione e interpretazione ambientale alla luce del livello di consapevolezza e sensibilità dei visitatori. La ricerca evidenzia interesse e sensibilità della domanda per le tematiche che concernono la sostenibilità, ma rileva altresì la necessità di adottare azioni e strumenti finalizzati a rinforzare le scelte sino ad ora adottate. Sebbene la ricerca incontri il limite di indagare un unico caso di studio, le peculiarità che contraddistinguono la Val di Tovel, lo portano ad essere un caso particolarmente significativo le cui *best practice* possono trovare applicazione anche per la gestione di altre aree naturali.

Il Parco Naturale Adamello Brenta rappresenta una concreta opportunità di sviluppo sostenibile per il territorio Trentino. Esso può rappresentare una fondamentale risorsa strategica in grado di produrre un forte vantaggio competitivo per l'area interessata e per gli stakeholder locali coinvolti. Il management di questa realtà naturale cerca di soddisfare le esigenze attuali, ma anche quelle future per garantire un mantenimento della condizione presente per le prossime generazioni.

Gli strumenti e i metodi utilizzati dall'Ente Parco hanno come finalità quella di incentivare un turismo sostenibile e ridurre l'impatto antropico prodotto sia dai visitatori che dalla comunità locale. Tuttavia, ad oggi, sebbene il Parco Naturale Adamello Brenta sia un'area protetta, risulta essere insufficiente la gestione dell'ambiente naturale al fine di garantire la salvaguardia dell'ecosistema presente e il mantenimento delle risorse naturali per le generazioni future. La ricerca si è focalizzata su una specifica area del Parco: la Val di Tovel. Essa ha subito negli ultimi anni, un aumento elevato delle presenze turistiche e ciò ha prodotto seri danni ambientali. Questa realtà si trova, come molte altre aree naturali, a dover bilanciare la soddisfazione dei visitatori con la salvaguardia dell'ambiente naturale e della biodiversità. I risultati emersi dalla ricerca dimostrano che i visitatori non sono ancora completamente consapevoli delle conseguenze che il turismo provoca alla Valle. Vi sono tuttavia alcuni dati legati alla sensibilità ambientale che evidenziano particolare attenzione verso azioni rispettose dell'ambiente (*e.g.* la raccolta differenziata, la riduzione di utilizzo di acqua).

La somministrazione di questionari agli operatori ha messo in luce come essi risultino maggiormente consci delle minacce ambientali che sta subendo la Val di Tovel a causa del grande

flusso antropico presente. Gli operatori possono essere visti come un campione della popolazione locale, dato che sono tutti residenti in zone limitrofe. In un prossimo futuro sarà fondamentale svolgere incontri di sensibilizzazione con la comunità per individuare azioni per la conservazione e valorizzazione del territorio.

Dal lato della domanda, la ricerca ha identificato il target principale al quale rivolgere le future strategie, ovvero coppie e famiglie, che congiuntamente coprono l'86,40% del totale. La profilazione dei rispondenti ha evidenziato anche la presenza di numerosi escursionisti (52,2%). Questo porta a riflettere sulla necessità di analizzare la possibile motivazione di un turismo "mordi e fuggi" ed eventuali soluzioni da adottare per aumentare la percentuale di turisti.

La ricerca evidenzia un interesse naturalistico e, in particolare, per le escursioni che rientrano tra le attività principalmente svolte in Valle. Elevata è anche l'apertura verso un accrescimento della propria conoscenza legata a tematiche ambientali. Si confermano pertanto i tratti tipici del turista 4L che interpreta la dimensione *leisure* della vacanza manifestando marcato interesse per il contesto paesaggistico e naturale del territorio (*landscape*) e per la propensione e ricerca di apprendimento innovativo e divertente (*learning*) generato grazie ad attività d'interpretazione e di educazione ambientale. Inoltre, secondo quanto emerso dall'analisi degli operatori, strumenti più tradizionali come l'aumento della sorveglianza e di sanzioni, vengono riconosciuti più efficaci. Una possibile soluzione a questa idea fortemente condivisa tra gli attori locali potrebbe essere la loro partecipazione in prima persona alle attività proposte e il loro coinvolgimento per la creazione di nuove idee di interpretazione ambientale. La ricerca mette in luce pertanto l'accettazione da parte dei visitatori della dimensione *limit* nella consapevolezza di contribuire in questo modo alla salvaguardia delle aree naturali.

A conclusione dell'analisi sin qui condotta emerge come la tutela della Val di Tovel si dimostri necessaria per salvaguardare le risorse naturali, quali la biodiversità e il paesaggio, che rappresentano i capisaldi dell'offerta turistica. Le tre attività di educazione ambientale, emerse dallo studio di best practices sono ipotesi fattibili in quest'area naturale. Gli stakeholder primari potrebbero adottarle per incentivare comportamenti maggiormente sostenibili tra i visitatori. L'ideazione delle attività va a coinvolgere, infatti, i due target principali emersi dalla ricerca: coppie e famiglie.

È fondamentale ricordare che i progetti e gli interventi che decideranno gli stakeholder primari, dovranno essere appoggiati anche dalla popolazione locale per garantirne l'efficacia. È la stessa comunità, infatti, che caratterizza l'ambiente apprezzato dal turista, ovvero la capacità di accogliere e creare un sistema di offerta efficiente che accresca la soddisfazione in merito alla qualità della vacanza. Le iniziative degli stakeholder sono determinanti, ma hanno bisogno della condivisione locale per creare un meccanismo virtuoso ed ottenere ricadute positive sul benessere economico della zona.

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Farmers' conflicting relation with management software. Evidences from durum wheat-pasta value chain in Italy♦

EMANUELE BLASI* CLARA CICATIELLO•

Abstract

Objectives. *This paper aims at assessing the trust of crop managers in digital tools intended to improve the efficiency of crop production and underline the implications on agri-food value chain supply management.*

Methodology. *Data on 4,376 plots cultivated with durum wheat across three years is gathered and used to study the use of a Decision Support System (DSS) by farm managers. The trust of managers in the DSS is measured as the shift between the quantity of fertilizer advised by the system and that supplied to the crop. A multinomial logistic regression is conducted, where the probability of plots to receive more or less fertilizer than advised by the DSS is analyzed against a set of factors.*

Findings. *Trusting the advices of the DSS leads to a greater productivity of the plots, while supplying more or less fertilizer than advised reduces the amount of grain harvested at the end of the season. The trust in the DSS is higher among managers that set more ambitious production targets, suggesting that an inclination to sustainable intensification is a prerequisite for a successful implementation of the tool.*

Research limits. *The number of plots concerned by the study increased across the study period, and meaningful geographical differences were detected, that could have affected the results of the model.*

Practical implications. *Increasing the awareness of managers over the advantages of digital tools and involving them in the design and implementation of these tools may help removing the barriers to a digital transformation of agricultural production.*

Originality of the study. *The focus on the application of a digital tool to farm management is interesting as agriculture is probably the sector where the higher reluctance of managers towards technological innovations exists.*

Key words: *decision support system; crop manager; eco-innovation; sustainable intensification; agri-food value chain*

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1. Introduction

Sustainability is a key challenge of our times, and firms and businesses of all sectors are called to reshape their activity along the principles of sustainability. Agri-food industries are faced with new managerial challenges concerning the transition of the supply value chain to new technological and socio-technical approaches, by implementing new business models intended to monitor and improve the social and environmental performances (Vellema and van Wijk, 2015, Brown *et al.*, 2015).

Recently, some food companies worldwide started a dialogue with the other actors of the supply value chain actors on the use of horizontal and vertical agreements to improve the sustainability of their businesses (Matopoulos *et al.*, 2007; Blasi *et al.*, 2017). Indeed, consumers are increasingly sensitive towards these topics, as a result of environmentally based education schemes and social messages (Braga, 2012).

Usually, food companies strongly encourage the adoption of private standards by the suppliers to accomplish food retailers' commitments, especially in terms of food safety and standardization of raw materials. With this aim, in the last years some multi-stakeholder initiatives emerged, involving food retailers, industries and producers. Their main focus is on the creation of a horizontal networking, by engaging actors directly and indirectly involved in the supply chain, as for example environmental associations and NGOs (Fuchs *et al*., 2011; Pagell and Wu, 2009; Smith 2008). In management studies, these dynamic relationships among food chain actors are often analysed as innovation networks seeking to develop a Sustainable Supply Chain Management (SSCM) as defined by Seuring and Mueller (2008).

In the food sector, farmers are pushed by policies and pulled by the consumers and the society as a whole to adopt new practices and to change their production activities along the principles of sustainable agriculture, which is broadly recognized to improve farm's environmental quality, economic profitability and social equity (Behnassi, 2011).

Govindan (2018) suggests that these new practices and sustainable approaches can be fostered by new relationships arising between actors following a SSCM vision. However, these practices are likely to be adopted only when players recognize opportunities to enlarge their business, by reducing their production cost and by adding new quality attributes to the uncharacterized commodities markets (Folkerts and Koehorst, 1997). Despite the availability of validated technological tools to improve the efficiency of agricultural production, farmers (and suppliers of the food sector in general) often lack the entrepreneurial skills to understand the benefits of innovations and to adopt them quickly (Grimm et al, 2014; Klerx et al, 2012). This is true also in developed regions, such as in Europe, where the adoption of innovations in the primary food production has to be supported by agricultural policies subsidizing farmers' investments (Pindado and Sanchez, 2017), or by the pressure exerted by food industry and/or retailers to their suppliers to ensure a higher level of sustainability of food products (Chkanikova, 2016).

The leading Italian food company Barilla is one of these firms, as it has been promoting sustainability and quality among durum wheat growers since 2008, when the Barilla Sustainable Farming project was launched (Blasi *et al.*, 2014). Reading the last three *Good for You Good for the Planet* Barilla Sustainability Reports, the company seems to have internalized the sustainability concepts, where environmental objectives are expressed as explicit targets for each raw material used in food production. Indeed, sustainability is conceived as a business commitment towards the modern consumer, not only a Corporate Social Responsibility (CSR) activity (Pagell and Wu, 2009). Nowadays Barilla employees are focused to improve the raw material sustainability's performances, by engaging new relationships with the up-stream value chains actors, mainly raw materials producers, farmers' cooperative, mills and processors (Pogutz and Winn, 2016; Russo et al. 2018) and looking at these interactions as a potential source of new information and data provided by big-data environment and ICT tools (Paiola 2018).

Using the information provided within the Barilla Sustainable Farming initiative, and the relative data on the quantity of durum wheat purchased by the company from 2013 to 2017, the case

study presented in the paper aims to study the dynamics of innovations' acceptance among farmers, as a result of an effort provided by the food industry, thus allowing outlining future challenges for agri-food industries managers to improve farmers and supplier capabilities to achieve resilient SSCM. Potential solutions will be proposed to improve and re-design an innovative sustainable business model based on big-data and ICT tools diffusion across the supply chain networks.

2. Agri-food chain innovation and ICT

The digital era offers significant opportunities for farmers and agri-food companies to improve the control over their production processes, thus making it easier to achieve sustainability targets (Hamprect *et al.*, 2015). This opens the way to more tailored decisions, likely resulting in a higher quality of products together with a more thorough control over sustainability performances. Such process is rooted in the principles of precision agriculture (Heuvel, 1996; Mc Bratney *et al.*, 2005; Aubert *et al*, 2012), i.e. a new business food production model, distinguished for a more efficient use of the inputs in crop management, thus allowing for a sustainable intensification. The objective of precision agriculture is therefore "an increase in agricultural production per unit of inputs" (FAO, 2004): the land unit productivity increases and a reduced impact on the environment is exerted per unit of food produced (Foley *et al.*, 2005, Tilman *et al.*, 2011).

Some authors regard this opportunity as a possible solution for the problem of feeding the increasing global population (Rockstrom *et al.*, 2017; Struik and Kuyper, 2017) while others argue that the main advantages will be linked to the higher economic performance that farm managers can achieve by increasing the yield per unit of land (Van Noordwijk and Brussaard, 2014). In this sense, the term "intensification" seems to be reductive as it only refers to the concept of efficiency of the inputs; alternative definitions of sustainable intensification have therefore been proposed, such as "ecological intensification" or "biodiversity based agriculture" to refer to new agricultural management practices where the use of inputs is reduced without threatening the production (Pretty, 2008; Horlings and Marsden, 2011; Altieri *et al.*, 2012; Duru *et al.*, 2015).

The main pillar of sustainable intensification practices is the search of tailored solutions for crop management, based on local conditions and on the productivity objectives set by the farm management, and harmonized at the same time with the global environmental problems (Tilman *et al.*, 2001; Garnett *et al.*, 2013).

In this domain, ICT and Big Data represent a great opportunity to monitor and assess the development of the crop on a regular basis, and to create management tools available to farmers that may support their decisions about the quantity and timing of inputs to be distributed. ICT are already widely used in agriculture, especially by farm advisors and extension services, that may take advantage by the use of remote sensing, earth observations, IoT, web-based forecasting alert (Atzberger, 2013).

In this study, we focus on the diffusion among farm managers of Decision Support Systems (DSS), a class of informatic application available to farmers and farm advisors, that address the use of nutrients, water and pesticides based on local and regional data (Wolfert *et al.*, 2017). DSS are intended to help farmers to manage a more complex and diversified cropping systems in the future, increasing both the agricultural systems efficiency and resilience (Zaks and Kucharik, 2011), while avoiding climate change risks mitigation, improving food safety and security and ensure a gain at the end of the production process (FAO, 2014). Despite the diffusion of these systems in the last decade, many barriers still exist to their full implementation on a large scale (Renning, 2000) which are more or less relevant depending on the production context, the organization of supply chains and markets, the institutional and norms framework as well on the type of product (Pierpaoli *et al.*, 2013, Long *et al.*, 2016; Oezle *et al*., 2016; Hasler *et al.*, 2017).

This paper investigates the use of the DSS within a panel of Italian durum wheat producers, who use the system as part of an agreement with Barilla, seeking to improve the level of sustainability of the durum wheat-pasta value chain. Field data are gathered on the use of the DSS

in durum wheat production, and they are used to assess the trust of farmers in this tool, as well as to study the factors underlying such trust. Results allow to discuss the potential diffusion of this innovation among agricultural businesses, and to provide a first assessment of its impact on the management of food production as well as on the sustainability of the food production systems.

3. Methodology

3.1 Description of the case study

With the aim to understand how the introduction of a digital tool for crop management shapes the production patterns in terms of input use and yield, we analyzed a three-years database of durum wheat cultivation where a DSS was used by crop managers. The DSS is called granoduro.net® and it is released by Horta s.r.l., a spin-off company of the Catholic University of Piacenza, specialized in the creation of interactive web tools to support agricultural businesses in the crop management, according to the principles of sustainable and precision agriculture.

This DSS is used in several farms that produce durum wheat for Barilla, global leader in the pasta market and major Italian pasta producer, as part of a supply agreement. Key issues of this agreement concern specific pre-cultivation sustainability criteria, quality cues of the grain, resulting in a premium price when the grain protein content exceeds a certain threshold, and the use of the DSS by the farmer throughout the production process.

The structure of this agreement derives from the long-running initiative Barilla Sustainable Farming (BSF), which was started in 2008. The BSF sought to push farmers to adopt proper crop rotations combined with the use of DSS, with the aim to reduce the environmental impact of the production and the costs related to inputs, while improving the quality of the grain (Blasi *et al.*, 2017).

The number of durum wheat growers joining these supply contracts with Barilla is increasing, moving from 640 to 2,000 farmers in the period 2013-2016. The agricultural area concerned by the application of this contract moved from 17,500 to 42,200 hectares in the same period, increasing the Barilla's supply of durum wheat semolina produced under these agreements from 13% to 37%.

The DSS granoduro.net® consists of a web-assistance service which integrates information on weather, soil and crop characteristics to provide the farmer advices on how to manage the crop. The crop manager is asked, at the beginning of the season, to set productivity objectives, and to report all the farming operations as they are performed on the field. The system collects, organizes and integrates all information, and provides suggestions to the users concerning the most appropriate operations to undertake to meet the production objectives. Therefore, it suggests farmers how to optimize seeding, fertilization, weed control, pests and disease management to preserve the durum wheat yield, both in terms of quantity and quality.

3.2 Data collection

This study is based on field data made available by Horta s.r.l., through a software that automatically records some of the most critical input and output data entries of granoduro.net®, for all the users. All information is recorded at the level of crop production unit (CPU), defined as a portion of soil with same characteristics in terms of durum wheat variety, preceding crop, soil texture and cultivation technique. This information is stored in a 'Crop Operations Register', a standardized database where crop data are included day by day at every stage of crop development.

Input data are added to the system by the crop manager, i.e. either the farmers' themselves or their advisors. This data includes the date of sowing, the quantity of seed used, the durum wheat variety and the target yield expected by the farmer. Output data concern the suggestions provided by the DSS to the crop manager, including the advised quantities of fertilizers, pesticides etc. to be used at every stage of crop production. This data is calculated by the system basing on the input

data added by the crop manager and the climatic conditions of the area where the CPU is located.

The database included 4,376 records, over three agrarian years from 2013 to 2016. The records referred to single CPU cultivated with durum wheat, in a specific year. Therefore, one farm could be present up to three times in the database, if it was cultivated with durum wheat across more years. Different CPUs could belong to the same farm, as they were recorded separately when non-homogeneous farming techniques were applied (e.g. two adjoining plots of the same farm where different varieties of wheat were sowed), or when they were not contiguous.

Each CPU was numbered with a code, and the following information was available for each observation:

- general data on the plot: size of the plot, elevation, location, farm of belonging, cultivation system (conventional or organic), year;
- type of seed (variety);
- date(s) of sowing;
- target yield set by the crop manager at the beginning of the year;
- quantity of nitrogen fertilizer advised by the DSS;
- quantity of nitrogen fertilizer used on the crop;
- total yield obtained at the end of the production process;
- yield per hectare obtained;
- humidity and protein rate in the grain harvested.

Basic descriptive elaborations were performed to show the geographical distribution of the observation, the average yield obtained in different areas of the country, and the quantity of fertilizer supplied to the crops.

3.3 Statistical analysis

In the statistical analysis of the data, we focus our attention on the quantity of nitrogen fertilizer supplied to the crops, one of the most important inputs affecting durum wheat quality. Here, we assume that the latter is the result of the indications provided by the DSS to the crop managers, which is mediated by the farmers' set of personal preferences and belief regarding the functioning and effectiveness of the support provided by the DSS. The shift between the quantity of nitrogen fertilizer advised by the DSS and the quantity supplied to the crop is here used as a proxy to assess the trust of farmers in the DSS.

Basing on the available data, a "N-shift" variable was created, where for each CPU the gap between the supplied and suggested quantities of fertilizer was expressed in percentage over the quantity of fertilizer suggested by the DSS. This variable assumes: a null value when the crop manager strictly follows the suggestion of the DSS with respect to the quantity of nitrogen fertilizer to be distributed; a positive value when a higher quantity of fertilizer is supplied with respect to what suggested by the DSS; a negative value when crop managers supply less fertilizer than suggested by the DSS. Fig. 1 shows the distribution of observation for the "N-shift" variable, which is normally distributed, as verified through the Kolmogorov-Smirnov test ($p<0.0001$). The descriptive statistics of the variable are reported in Table 1.

In the statistical analysis of the data, we considered this shift as a proxy of farmers' trust in the DSS. The N-shift variable was therefore analyzed through univariate techniques, by studying its relations with other single variables of the database, through ANOVA and correlations.

A statistical model was set to study the factors affecting farmers' trust in the DSS. Due to the large variability observed in the N-shift variable, a transformation of it was used to set the model. Namely, a categorical variable expressing the degree of trust of the farmers in the DSS was constructed basing on the "N-shift" data. Following the quartiles of the N-shift variable (reported in Table 1), a new variable named "Class of N-shift" was created, with the observations being divided in three classes:

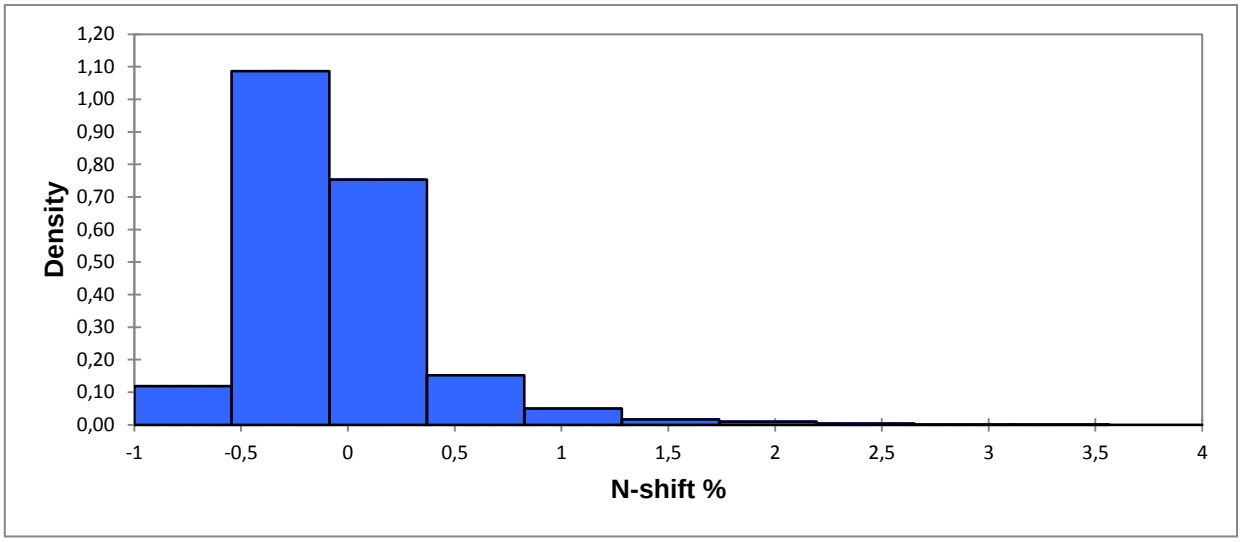
A. observations belonging to the second and third quartiles, corresponding to plots where the shift between the quantity of fertilizer supplied and advised was limited between -30.4% and +7.8%

with respect to the quantity of fertilizer suggested by the DSS (2,190 observations, 50% of the total);

B. observations belonging to the first quartile, corresponding to plots where less that -30.4% of nitrogen fertilizer was supplied, with respect to the quantity advised by the DSS (1,093 observations, 25% of the total);

C. observations belonging to the fourth quartile, corresponding to plots where more than +7.8% of nitrogen fertilizer was supplied, with respect to the quantity advised by the DSS (1,093 observations, 25% of the total).

Fig. 1: Distribution of the N-shift variable (N=4,376)



Source: our elaboration

Tab. 1: Descriptive statistics of the N-shift variable

Descriptive statistic	**N-shift %**
Number of observations	4376
Min	-0,832
Max	3,465
1° quartile	-0,304
Median	-0,117
3° quartile	0,078
Mean	-0,057
Variance (n-1)	0,162
Standard deviation (n-1)	0,402

Source: our elaboration

The "Class of N-shift" variable was first studied through univariate techniques, by studying its relations with other single variables of the database, by means of ANOVA and correlations. Then, it was used as a dependent variable of a multivariate analysis. The model selected for the analysis was a multinomial logistic regression, with the aim to study the influence of a number of factors on the probability of farmers to supply less/more/same quantity of fertilizer with respect to the quantity advised by the DSS, and more in general their trust in this crop management innovation. In the logistic regression, the following factors were considered:

- Number of CPUs cultivated with durum wheat in the same farm;
- CPU size (hectares);
- Total size of the farm (hectares);
- Target yield (tons/hectares) as inputted in the DSS by the crop manager at the beginning of the

season, expressed in tons per hectare;

- Quantity of sowed seed (kg/hectare);
- Number of interventions in the CPU during the production season, intended as a proxy of farmers' propensity to operate on the crop;
- Agrarian Season (2013, 2014 or 2015);
- Geographical area where the CPU is located (North or Centre/South Italy);
- Farming system, distinguished between conventional or integrated (production process with low inputs).

4. Results

4.1 Descriptive statistics of the observations

About half of the observations were located in the North of Italy, where the DSS was most spread among the farmers cultivating durum wheat (Tab. 2). On average, 5.5 tons per hectare of durum wheat were harvested in the plots considered in the study, with a minimum of 1.3 and a maximum of 10.0.

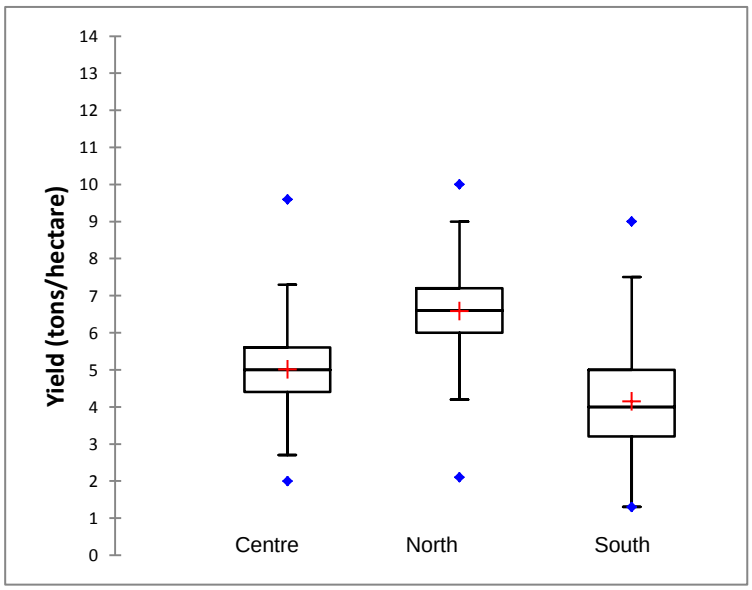
The yield obtained at the end of the crop was strongly related to the geographical area where the plots were located (Fig. 2). Namely, CPUs located in the North of Italy had an average yield significantly higher than the plots located in the Centre or South areas ($p<0.0001$ as tested with ANOVA). For this reason, in the multivariate analysis, CPUs from the Centre and South of Italy were aggregated in a single class, named "Central-South". This also increased the consistency of the subdivision of the observations among the geographical classes.

Tab. 2: Distribution of the observations per geographical area

Geographical area	Observations	% observations
North	2,197	50%
Centre	1,055	24%
South	1,124	26%
Total	4,376	100%

Source: our elaboration

Fig.2: Yield obtained at the end of the production process, per geographical area



Source: our elaboration

4.2 Univariate analysis

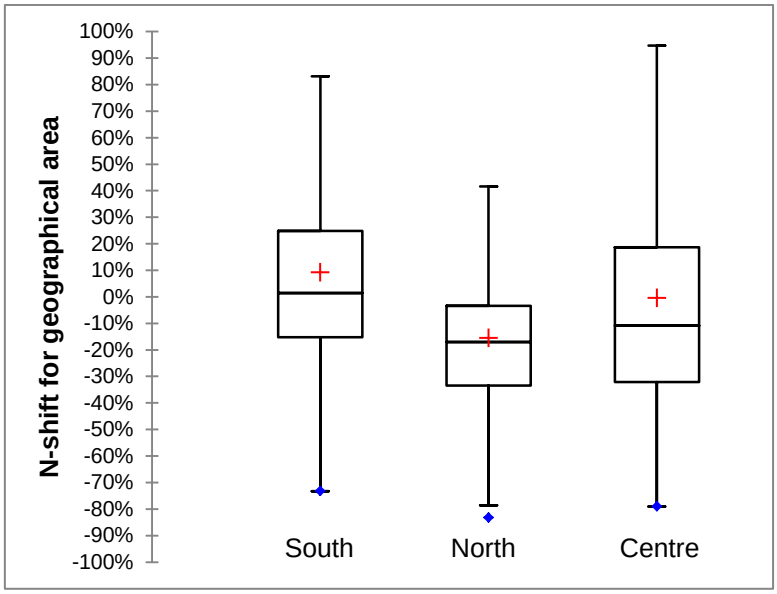
In the univariate analysis, the shift between the quantity of fertilizer advised by the DSS and actually supplied to the crop was studied against single other variables. This helped to understand which possible factors were linked to the choice of the farmers.

The quantity of fertilizer provided to the crop by the farmers was strongly linked to the geographical area, as plots located in the Centre and North of Italy received, on average, over 150 kg/ha of fertilizer, whilst CPUs located in the South of Italy received slightly less than 120 kg/ha on average. After being tested with an ANOVA analysis, such differences among the geographical areas covered by the sample proved to be significant with $p<0.0001$.

The quantity of fertilizer provided to the crop was linked with the yield obtained at the end of the production process (correlation coefficient = 0.21), but it did not emerge as a major driver of the harvested quantity of durum wheat; indeed, a simple linear regression model among these two variables, taking the yield as the dependent variable and the quantity of fertilizer as explaining factor, showed a R-squared value of only 0.044.

With regard to the "N-shift" variable, the average shift was -5% compared to what suggested by the DSS. The difference between the quantity of fertilizer suggested by the DSS and the quantity actually provided by farmers to the crop was significantly different in the three geographical areas of the country (Fig. 3).

Fig. 3: Share of N-shift per geographical area



Source: our elaboration

Namely, in the plots located in the North of Italy farmers were more likely to provide less fertilizer than suggested by the DSS (-15.5% on average); instead, the shift was less significant in the production units located in the Centre and South of Italy, and farmers' were more likely to either provide crops with more fertilizer than suggested by the DSS (+9.2% on average in plots located in Central Italy) or to follow the indications of the system (-0.4% of fertilizer provided on average to crops located in South Italy). All these differences are significant with $p<0.0001$ when tested with ANOVA.

These analyses confirmed that the CPUs located in Central Italy show intermediate features with respect to plot located in the North and South of Italy, and considering the number of plots in each area, we decided to combine the Centre and South categories in order to divide plots along two geographical areas: North and Central-South Italy. These categories counted respectively 2,197 and 2,179 observations.

4.3 Results of the logistic regression

As mentioned in the methodology, farmers' trust in the DSS advices about the quantity of fertilizer to be distributed was studied, by creating a three-classes variable where:

- Class A included CPUs where the shift between the quantity of fertilizer advised by the DSS and the quantity of fertilizer actually provided to the crop was relatively small (therefore farmers' seemed to trust the advises of the DSS);
- Class B included CPUs where significantly less fertilizer was provided, with respect to the quantity suggested by the DSS;
- Class C included CPUs where significantly more fertilizer was provided, with respect to the quantity suggested by the DSS.

The probability of each CPU to belong to B or C categories was studied through a multinomial logistic regression model, keeping category A as reference, with respect to a set of predictors, listed in Tab. 3 (quantitative factors) and Tab. 4 (categorical factors).

Tab. 3: Quantitative factors used in the logistic regression (N=4,376)

Variable	Min	Max	Mean	Std. deviation
Number of CPUs in the farm	1	33	3.473	4.681
CPU size (hectares)	0.350	818.880	15.268	27.819
Total size of the farm (hectares)	0.400	2412.210	53.576	118.745
Target yield (tons/hectares)	2.000	10.000	5.870	1.236
Quantity of sowed seed (kg/hectare)	120.000	337.000	211.166	25.746
Number of interventions in the CPU during the production season	0.000	13.000	5.872	1.556

Source: our elaboration

Tab. 4: Categorical factors used in the logistic regression (N=4,376)

Variable	Categories	Observations	% obs.
Agrarian Season	2013-2014	737	16.842
	2014-2015	1654	37.797
	2015-2016	1985	45.361
Geographical area	Central-South Italy	2179	49.794
	North Italy	2197	50.206
Farming system	Conventional farming	4077	93.167
	Integrated farming[1]	299	6.833

Source: our elaboration

The model showed a good significance and goodness of fit, with a R-squared (Nagelkerke) of 0.292. Tab. 5 reports the parameters of the model. The interpretation of these results shall look specifically to the following issues:

1. the value of the parameter of each factor: if it is positive (negative), then an increase of the variable increases (decreases) the probability of the observations to fall in the respective category of the dependent variable;
2. the significance of the factor in influencing the probability of the observations to fall in the different categories of the dependent variable;
3. the odds ratio, i.e. the ratio between the probability of success (falling into the respective category of the dependent variable) and the probability of failure (not falling into the respective category of the dependent variable).

As mentioned, class A of the dependent variable is taken as the reference category, therefore categories B (providing less fertilizer than suggested) and C (providing more fertilizer than

[1] Integrated farming is a widespread agricultural management option in Europe, that aims to reduce the use of chemicals in crop production by favoring preventive methods and biological pest control.

suggested) are analyzed separately to each other, and the probability of success or failure of the observations are calculated with respect to the A category.

Some factors were significant for both the B and C classes of the dependent variable. Namely, expecting a higher yield decreases the probability of observation to fall in both categories, although such effect is much more pronounced for the C class, corresponding to providing more fertilizer than advised by the DSS. The number of interventions on the field completed by the farmers on the plots increased the probability to provide more fertilizer than suggested by the DSS (class C), and decreased the probability to provide less of it (class B). Also, sowing more seed had a slight effect on the probability of observation to fall in class B (negative effect) and C (positive effect).

Other factors were significant for only one category of the dependent variable. Belonging to a large farm slightly decreased the probability of the plots to fall in the B class (providing less fertilizer than suggested by the DSS). As expected, the geographical location of the plots also significantly influenced the probability to provide less fertilizer to the crop; namely, plots located in the North of Italy showed a high probability to fall in the B class with respect to plots located in Central or South Italy. Instead, CPUs cultivated with durum wheat in the season 2015 showed a higher probability to be supplied with more fertilizer than required (class C).

Tab. 5: Categorical factors used in the logistic regression (N=4,376)[2]

Class of N-shift	Factors	Parameter	Wald Chi^2	Pr > Chi^2	Odds ratio
B (less fertilizer)	Number of CPUs in the farm	-0.020	1.738	0.187	0.980
	CPU size	0.003	1.834	0.176	1.003
	Total size of the farm	-0.001*	3.032	0.082	0.999
	Target yield	-0.179***	14.474	0.001	0.836
	Quantity of sowed seed	-0.003**	4.254	0.039	0.997
	Number of interventions in the CPU	-0.144***	30.740	< 0.0001	0.866
	Season - 2013	0.000			
	Season - 2014	-0.029	0.067	0.796	0.971
	Season - 2015	0.113	1.069	0.301	1.119
	Geographical area - Central-South	0.000			
	Geographical area - North	0.369***	9.674	0.002	1.446
	Farming system - conventional	0.000			
	Farming system - integrated	-0.092	0.355	0.551	0.912
C (more fertilizer)	Number of CPUs in the farm	0.002	0.026	0.873	1.002
	CPU size	0.002	0.667	0.414	1.002
	Total size of the farm	0.000	0.046	0.830	1.000
	Target yield	-0.858***	275.865	< 0.0001	0.424
	Quantity of sowed seed	0.010***	34.064	< 0.0001	1.010
	Number of interventions in the CPU	0.155***	35.415	< 0.0001	1.168
	Season - 2013	0.000			
	Season - 2014	0.111	0.851	0.356	1.117
	Season - 2015	0.303***	6.940	0.008	1.353
	Geographical area - Central-South	0.000			
	Geographical area - North	0.150	1.458	0.227	1.162
	Farming system - conventional	0.000			
	Farming system - integrated	0.134	0.618	0.432	1.143

Source: our elaboration

5. Discussion

The digital transformation of agricultural businesses faces many barriers, but this evolution is crucial to achieve a sustainable intensification of food production. Farmer advisors and technicians, who are very often the people in charge of managing production processes, play a central role in innovation brokering, as well as all the actors involved in the local agricultural knowledge information systems (Dedieu *et al.*, 2009; Dorè *et al.*, 2011; Klerx *et al.*, 2012). This innovation

[2] Parameters significant for α<0.01, α<0.05, α<0.10 are marked with ***, **, * respectively.

networking activity is generally supported by public policies but, recently, it has also been supported by private food corporations and agro-food chain actors (Smith, 2008; Dentoni and Peterson, 2011), as in the case study analyzed in this paper.

The farms involved in the analysis cannot be considered representative of the Italian durum wheat producer, as their yield is significantly higher than the national average (ISTAT, 2011). This was largely expected given that they are a self-selected group of businesses adhering to a voluntary agreement with their industrial counterpart (Barilla). Therefore, it seems that these businesses were already inclined towards a sustainable intensification strategy (Blasi *et al.*, 2014), connected to agro-industrial food credence cues, which are increasingly used in the communication strategy by the agri-food company (Fernqvist and Ekelund, 2014).

Looking for "intensification" means, in the use of the DSS, to set a reasonably high target of yield to be pursued during the season. The results show very clearly that when the crop managers set a high target yield, they are more likely to trust the advices of the DSS, giving neither more nor less nitrogen fertilizer than recommended. Instead, those who set less ambitious targets tend to provide the crop either less fertilizer or, more frequently, more fertilizer than recommended. This is a very interesting effect, suggesting that the system performs better when the user is already inclined to a sustainable intensification of the production. Setting higher production targets may also be interpreted as a more managerial approach to crop production, which may be typical of innovative farms. Disregarding the recommendations of the DSS may be a consequence of the willingness of farmers to keep the usual routine in crop management, due to a general reluctance towards innovations (Avolio *et al.*, 2014) and/or a conflicting relation with digital instruments and data sharing (Kosior, 2017). In the agricultural sector, much more than in other industries, many barriers exist to the digital transformation process (Crossan and Apaydin, 2010). One key issue is the limited access to high-speed broadband and mobile networks in rural regions, also in the most developed countries (Mark *et al.*, 2016), which goes together with the lack of digital skills by farmers, resulting in low participation in online activities and a reluctant approaches to data sharing (Castle *et al.*, 2016). This may partly be linked to the aging of farms' managers that still holds in Italy (Zagata and Sutherland, 2015), besides some interesting changes are observed in the structure of the farmers' population in recent years, with the increasing presence of youths and women among farm managers. To overcome these barriers, involving farmers in the process of designing and developing digital applications and tools seems crucial for the further uptake of the technology (Lindblom *et al.*, 2016; van der Weerdt and de Boer, 2016). This may explain the successful uptake of the DSS among many of the farmers involved in this study, as they were highly involved in the first developments of the tool promoted by Barilla.

If we check the actual yield achieved by the three groups of companies (A, B and C), we find that those who trust the DSS (group A) get the highest average yield of 5.8 tons per hectare; group B is just below (5.7 tons/hectare), while group C (those that give more nitrogen than recommended) shows a lower yield (5.0 tons/hectare). Therefore, farms in group C spill more fertilizer than needed, and at the same time they are not able to achieve a greater yield, as a result of this intensification. We may say that their managerial choices are not effective to achieve a higher productivity and, at the same time, they result in a less sustainable production process.

Some limitations should be mentioned regarding the presented results. First, the large variability of the data on the use of fertilizers in the surveyed firms may have affected the results of the logistic regression model. Second, it should be considered that the number of farmers and plots concerned by the use of the DSS increased along the study period, so that the number of observations is not consistent across the three seasons considered. This could have led to some bias of the results.

6. Conclusions

Looking for a sustainable intensification of agricultural production is crucial to meet the growing global food demand. Digital tools and data sharing may support this process, providing the

increased management control needed to let agricultural production being more productive with less inputs. In this study, we analyzed the use of a digital DSS among a large group of farmers participating to the "Barilla Sustainable Farming" project, with respect to durum wheat cultivation. This tool provided crop managers - either the farmer or a technician - with advices concerning the amount of fertilizer to be used on the crop. Here, we measured the extent to which crop managers accepted and implemented the suggestions provided by the system, by analyzing the factors underpinning such choice.

Results suggest that trusting the DSS carried meaningful advantages for farmers in terms of final production, as well as in terms of efficiency in the use of inputs. In general, being already inclined to sustainable intensification of the production seems to be a crucial factor shaping the use of the tool.

The agro-food sector reveals structural and systemic differences compared to others, and external critical factors seem to be responsible of heterogeneous outcomes (Grimm et al., 2014), as figured out by the case study analyzed. It is undoubtable that many barriers exist, especially in agriculture, to the adoption and diffusion of digital tools by farmers and crops managers. Within the same value chain, barriers could be overcome by considering production and processing geographical features, as well as the cultural and empowerment divide of rural communities (Bitzer & Glasbergen, 2015). Supporting collaborative practices aimed to reduce asymmetric information and to increase trustiness between processors, supplier and sub-supplier has also been discussed as a strategy to enhance the adoption of innovation in the primary sector (Lambrecht et al 2015).

A key issue for pushing the digital transformation in agricultural businesses is then the improvement of the knowledge chain, i.e. the linked steps by which data are processed into information, knowledge and finally wisdom as used in decision making (Janssen *et al.*, 2017), and the promotion of a greater awareness among managers about the advantages of using ICTs in crop management.

Context variables and opinion makers are likely to have a key role in this process, as farmers may be strongly influenced by the behavior of their peers, probably more than it happens in other sectors (Lambrecht et al., 2015). In this light, the approach of technicians to digital tools and data sharing becomes crucial as they can act as innovation brokers to farmers.

The results also show that the diffusion of a technical innovation intended to improve the efficiency of Italian primary sector is characterized by a structural slow adoption (Avolio *et al.*, 2014). This is probably due to a general risk aversion by cereals growers and to the low value added generally recognized to durum wheat in the competitive national and international market, differently from what happens for other agricultural production processes, such as wine making (Lenzi, 2013).

Here, the industrial food company (Barilla) sustainability strategy pulls up-stream value chain actors to get over innovation barriers. A new business models is defined, where a quality output-based premium (grain protein content premium price) is also bounded to the DSS introduction in the crop cultivation by durum wheat suppliers. However, this strategy is not fully accomplished as several durum wheat producers are not yet convinced or conscious about the potential benefits of adopting the DSs, both in terms of cost saving and potential gains in revenues. To solve this conflicting relation between DSS and users, looking at "Barilla Sustainable Farming" project, a closer relationship between farmers and their associations, land owners, farm advisors, brokers and buyers seems to be essential to share knowledge across value chain actors (Oelze et al., 2016), and to facilitate the transition phase (Pogutz and Winn, 2016).

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Impatto socio-economico di una infrastruttura di ricerca: una metodologia di misurazione

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Abstract

Obiettivi: *Le infrastrutture di ricerca sono componenti essenziali non solo del progresso scientifico e tecnologico ma in generale della ricchezza socio-economica del territorio in cui operano. Risulta pertanto fondamentale l'interpretazione e la rappresentazione ex ante del valore potenziale di un'infrastruttura di ricerca su un territorio, della sua capacità di creare shared-value. Date queste premesse, lo studio si pone come obiettivo la definizione di una metodologia in grado di misurare la ricchezza incrementale generabile da una determinata infrastruttura di ricerca.*

Metodologia*: L'impatto dell'infrastruttura viene rilevato seguendo un approccio integrato che tiene conto sia dell'impatto economico diretto, indiretto e indotto che dell'impatto sociale. Ciascuna tipologia di impatto segue delle differenti regole di stima e misurazione.*

Risultati*: Nell'articolo la metodologia delineata viene applicata ai Laboratori Nazionali del Sud, infrastruttura di ricerca parte dell'Istituto Nazionale di Fisica Nucleare che opera sul territorio italiano. I risultati mostrano che gli investimenti e la gestione dell'infrastruttura nel periodo 2013-2023 sono trasformati in ricchezza per il territorio con un valore aggiunto di 1,7.*

Implicazioni pratiche*: Lo studio può essere di interesse per i policy maker in quanto facilita i loro processi decisionali nella fase ex-ante la realizzazione di una infrastruttura di ricerca. L'analisi può essere anche di supporto ai Principal Investigator a capo di progetti di realizzazione di infrastrutture di ricerca, orientandone l'attività verso la creazione di un maggiore shared-value.*

Limiti della ricerca: *Lo studio presenta una proposta preliminare per la definizione dell'impatto socio-economico di un'infrastruttura di ricerca. La ricerca richiede ulteriori approfondimenti empirici.*

Originalità*: La ricerca contribuisce alla definizione di una metodologia per la misurazione ex ante della ricchezza incrementale generabile da una infrastruttura di ricerca.*

Parole chiave: *infrastrutture di ricerca, shared-value, impatto socio-economico, sostenibilità*

Objectives of the paper: *Research infrastructures are essential components not only of scientific and technological progress but in general of the socio-economic wealth of the territory in which they operate. Therefore, the interpretation and the ex-ante representation of the potential value of a research infrastructure on a territory, of its ability to create shared-value, is essential. Given these premises, the objective of the study is the definition of a methodology able to measure the incremental wealth generated by a specific research infrastructure.*

Methodology: *The impact of the infrastructure is detected following an integrated approach that takes into account both the direct, indirect and induced economic impact and the social impact. Each type of impact follows different estimation and measurement rules.*

Results: *In the article, the methodology is applied to the Laboratori Nazionali del Sud, a research infrastructure part of the Istituto Nazionale di Fisica Nucleare that operates in Italy. The results show that investments and infrastructure management in the period 2013-2023 are transformed into wealth for the territory with an added value of 1.7.*

Practical implications: *The study may be of interest to policy makers as it facilitates their decision-making processes in the ex-ante phase the realization of a research infrastructure. The analysis can also support the Principal Investigator in charge of projects for the construction of research infrastructures, directing their activity towards the creation of greater shared-value.*

Limitations of the research: *The study represents a preliminary approach to define the socio-economic impact of a research infrastructure. The research will require further empirical evidences.*

Originality: *The research contributes to the definition of a methodology for the ex-ante measurement of incremental wealth generated by a research infrastructure.*

Keywords: *Research Infrastructure; shared-value; socio-economic impact; sustainability*

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1. Introduzione e obiettivo dello studio

Policy maker e società civile presentano aspettative sempre più crescenti sulle infrastrutture di ricerca quali componenti essenziali non solo del progresso scientifico e tecnologico ma in generale della crescita socio-economica del territorio regionale e nazionale in cui si realizzano (European Commission, 2010; ESFRI, 2008, 2010; Technopolis, 2011; FSE, 2013). In uno studio di Nicotra *et al.* (2017), gli autori definiscono e applicano una metodologia di analisi di impatto all'infrastruttura KM3NET-ITALIA, un telescopio di dimensioni dell'ordine di un kilometro cubo installato nelle profondità marine di Capo Passero (SR) per la rilevazione di neutrini cosmici. Si tratta di un'infrastruttura realizzata e gestita dai Laboratori Nazionali del Sud (LNS). Nel presente articolo l'analisi di impatto si amplia per definire l'impatto generale dei Laboratori Nazionali del Sud nel loro complesso.

I LNS fanno parte dell'INFN, che comprende quattro Laboratori Nazionali, 20 Sezioni, e tre Centri Nazionali (CNAF, GGI e TIFPA). L'INFN è presente in cinque continenti e in oltre 30 paesi. Questa condizione di forte internazionalizzazione è dettata dalla natura globale della collaborazione scientifica nel campo della fisica. Tra le tante attività internazionali è di primaria importanza quella che si svolge presso il CERN di Ginevra. Al CERN operano gruppi di ricerca INFN (circa 1000 ricercatori), impegnati in tutti gli esperimenti condotti sia con l'acceleratore di particelle LHC (CMS, ATLAS, ALICE, LHCb, LHCf, Totem) che con l'acceleratore SPS (COMPASS).

L'INFN è anche molto impegnato nelle attività sperimentali che si svolgono presso altri grandi Laboratori all'estero come FERMILAB, SLAC, BNL, e JLAB (Stati Uniti); PNPI, BINP e JINR (Federazione Russa); CIAE e IHEP (Cina); RIKEN e KEK (Giappone), DESY e GSI(Germania), ESRF (Francia), PSI (Svizzera) ecc. L'INFN inoltre partecipa a programmi europei nei settori del calcolo scientifico e della fisica nucleare.

L'attività dei Laboratori Nazionali del Sud (LNS) è principalmente volta alla ricerca di base nel settore della Fisica Nucleare, dell'Astrofisica Nucleare e Particellare, ma anche alla ricerca applicata, quale la Fisica degli acceleratori, la Fisica dei plasmi, la Fisica nucleare applicata alla medicina, alla biologia e ai beni culturali, il monitoraggio ambientale e di scorie radioattive, l'irraggiamento di componentistica per l'industria aerospaziale.

Relativamente al settore della Fisica Nucleare, i LNS sono dotati di due acceleratori di particelle, un Ciclotrone Superconduttore ed un Tandem. Questi forniscono fasci di ioni dall'idrogeno al piombo con energie sino a diverse decine di MeV per nucleone. Con il metodo di frammentazione in volo è anche possibile produrre fasci di ioni radioattivi Attraverso grandi apparati di rivelazione (CHIMERA, MAGNEX, MEDEA) e altri apparati dedicati vengono studiate le proprietà della materia nucleare.

Per l'Astrofisica Particellare, i Laboratori Nazionali del Sud hanno realizzato due infrastrutture di ricerca sottomarine al largo della Sicilia Orientale: una a 2100 m di profondità, 25 km ad est del porto di Catania, l'altra a 3500 m di profondità a circa 90 km a Sud-Est di Capo Passero (SR), chiamata KM3NeT. Entrambe le infrastrutture sono connesse a laboratori di terra tramite un cavo elettro-ottico che permette di alimentare osservatori abissali e trasmettere ed acquisire i dati in tempo reale. I laboratori di terra sono, a loro volta, connessi ai LNS su fibra ottica, creando la più estesa rete di osservatori sottomarini real-time nel Mediterraneo.

Ai LNS la ricerca applicata avviene operativamente in una sala di irraggiamento per la proton-terapia (CATANA), un laboratorio per i beni culturali (LANDIS), un laboratorio per la radioattività ambientale e altri laboratori per attività multidisciplinari (fotonica, biologia, chimica, ecc.). Dal mese di febbraio 2002 CATANA (Centro di AdroTerapia ed Applicazioni Nucleari Avanzate) è attivo presso i LNS ED è attualmente l'unico centro in Italia dove è possibile trattare, mediante fasci di protoni, i tumori della regione oculare. Il Ciclotrone Superconduttore in grado di accelerare fasci di protoni fino ad una energia massima di 60 MeV. Questa caratteristica rende i fasci di protoni presenti nel centro particolarmente adatti al trattamento radioterapico di patologie neoplastiche di rara frequenza, quale ad esempio, il melanoma oculare. Per questo motivo il centro è interamente ed esclusivamente dedicato alla cura dei tumori della regione oculare, ed, in particolare,

del melanoma oculare. Il centro ha trattato, ad oggi più di trecento pazienti affetti da varie forme di tumore intraoculare.

LANDIS (Laboratorio di Analisi Non Distruttive In Situ), come anticipato, è un laboratorio applicativo che fornisce tecnologie innovative che fanno uso di raggi X per la caratterizzazione non distruttiva di materiali archeologici e di interesse per il patrimonio culturale. Ad oggi la tecnica di analisi che utilizza i raggi X risulta ben consolidata tra gli studiosi (archeologi, storici dell'arte, scienziati di conservazione, etc.) in quanto offre la possibilità di affrontare i problemi riguardanti la conoscenza e la conservazione delle opere d'arte in maniera sicura e "in situ".

Le tecniche sviluppate dal laboratorio LANDIS sono principalmente basate sulla Spettrometria X e sull'Analisi con Fasci di particelle cariche. Essi consentono l'analisi della composizione locale dei campioni (PIXE portatile e XRF), l'imaging elementale bidimensionale o tridimensionale (Scansione micro XRF, Scansione macro XRF, Full Field XRF e XRF confocale) e la loro caratterizzazione mineralogica (XRD portatile). Inoltre, la possibilità di utilizzare particelle cariche accelerate dal Tandem e dal CS ai LNS in un intervallo di energia ampia (da pochi MeV a 80 MeV nel caso di protoni) hanno permesso al gruppo di LANDIS di sviluppare tecniche nucleari di analisi (PIXE, Scansione macro PIXE, Full Field PIXE, analisi tramite attivazione Protonica e analisi basata sulla emissione prompt di gamma) specificamente dedicate all'indagine su manufatti di importanza artistica e culturale.

Diventa pertanto rilevante misurare l'impatto socio-economico che i LNS hanno realizzato e continuano a generare per il territorio siciliano e nazionale. Definire l'impatto socio-economico significa misurare la nuova ricchezza incrementale generata dalla realizzazione dell'infrastruttura sul territorio.

Nello specifico, per i LNS, si rilevano nel presente studio le seguenti tipologie di impatto:

- impatto economico diretto, cioè correlato ai trasferimenti in denaro sotto forma di salari/stipendi/provvigioni, tasse e profitti reinvestiti;
- impatto economico indiretto, generato nel sistema economico attraverso la catena produttiva formata dai fornitori di beni e servizi di attività direttamente riconducibili al settore analizzato;
- impatto economico indotto, generato attraverso le spese ed i consumi indotti dall'impatto diretto ed indiretto. Questo è costituito dall'aumento della spesa che si registra nell'area geografica di riferimento dove aumenta l'attività economica di fornitori di beni e servizi la cui attività non è direttamente riconducibile al settore analizzato;
- impatto sociale, derivante, tra l'altro, dal valore dei brevetti generati, degli spin-off creati, delle pubblicazioni scientifiche, del capitale umano formato, dal knowledge spillover;

La somma delle singole valorizzazioni fornisce la stima totale dell'impatto generato dall'infrastruttura.

Al complesso globale degli effetti economici e sociali dei LNS analizzati e stimati attraverso il modello di analisi è stata attribuita la definizione di "impatto generale LNS", volendo con questo termine raccogliere tutte le implicazioni di ordine economico e sociale che potrà generare. L'impatto dei LNS identifica dunque l'intera stima degli effetti socio-economici fornita attraverso la metodologia definita ad hoc ed impiegata nel presente lavoro.

L'impatto viene stimato a partire dall'anno 2013, anno che segna l'avvio di un orientamento dei LNS verso all'attrazione di fondi strutturali comunitari per l'attuazione di grandi investimenti, fino all'anno 2023, anno in cui presumibilmente si potranno già misurare alcuni effetti derivanti dalla conclusione del progetto POTLNS "Potenziamento dell'Infrastruttura di Ricerca Laboratori Nazionali del Sud per la produzione di fasci di ioni ad alta intensità da utilizzare in Fisica Nucleare e Interdisciplinare". POTLNS è un progetto di potenziamento dell'intera infrastruttura su cui i Laboratori stanno da tempo investendo. Come anticipato, ai LNS, le proprietà della materia nucleare vengono studiate utilizzando i fasci dei due acceleratori, gli apparati di rivelazione e apparati dedicati che possono essere installati in una delle sale sperimentali disponibili. Tra le attività indicate, alcune sono limitate dall'intensità dei fasci disponibili, che allo stato attuale rende impossibile la ricerca di fenomeni che richiedono prestazioni più elevate degli acceleratori, in particolare del Ciclotrone Superconduttore, e degli apparati sperimentali. Col progetto POTLNS

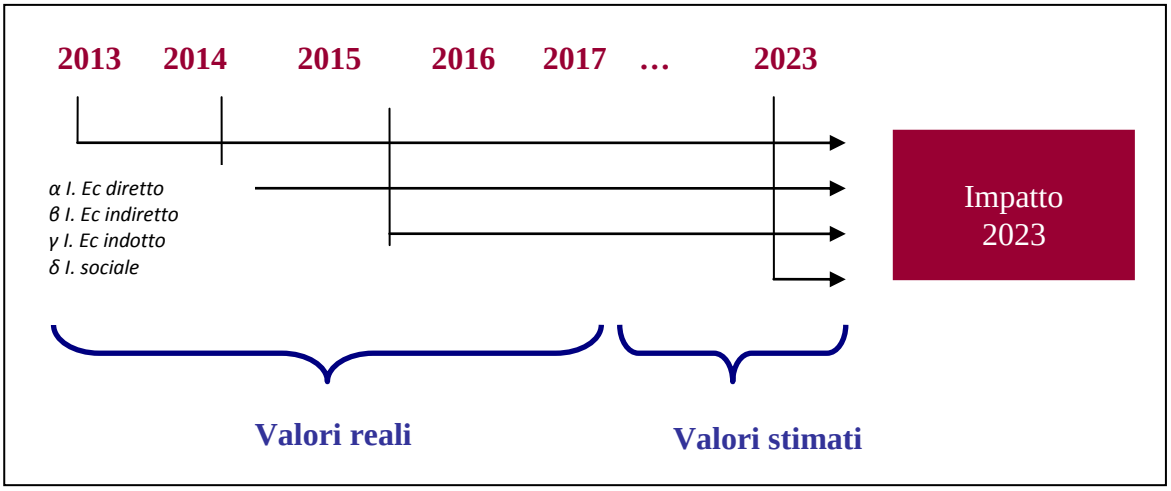
l'obiettivo è quello di aumentare l'intensità dei fasci del Ciclotrone fino a 10^14 pps.e la disponibilità di fasci di protoni, implementando un nuovo modo di estrazione del fascio. Si tratterà di una svolta rilevante per i LNS perché aprirà una serie di nuove e interessanti prospettive, auspicate dalla comunità di ricercatori nazionali ed esteri, sia per lo studio delle proprietà dei nuclei altamente esotici sia per lo studio di reazioni di fondamentale importanza per comprendere la nucleosintesi nell'universo e la struttura e l'evoluzione di oggetti e processi di interesse astrofisico. Ciò consentirà di rafforzare enormemente il già importante ruolo dei LNS nell'ambito delle infrastrutture di ricerca per la fisica nucleare esistenti in Europa.

L'analisi pertanto si basa su valori effettivi per il periodo di tempo che va dal 2013 al 2017. Per gli anni successivi i dati derivano in parte dal budget di progetto POTLNS, in altra parte vengono stimati.

Come si accennava sopra, l'infrastruttura sviluppa il suo potenziale scientifico sociale nel lungo termine e l'adozione di un orizzonte temporale esteso è necessaria per una valutazione completa delle sua prestazione. Tuttavia, la misurazione dell'impatto su un periodo di tempo maggiore rispetto a quello preso in considerazione in questo studio creerebbe problematiche sull'attendibilità delle stime che si effettuano.

Pertanto, pur con la consapevolezza delle enormi potenzialità in termini di impatto generato in un lontano futuro, le stime nel presente lavoro si fermano al 2023.

Fig. 1: *Struttura dello studio di impatto*



Fonte: Nostra elaborazione

L'analisi di impatto è uno strumento finalizzato a informare sul beneficio economico e sociale che la società ricava dai LNS e dal loro potenziamento. I benefici, anche quelli sociali e ambientali vengono qui espressi attraverso una quantificazione monetaria a prezzi contabili.

L'interpretazione e la rappresentazione dei processi di creazione di valore e generazione di impatto sul territorio per tutti gli stakeholders di una infrastruttura di ricerca (si veda Tab. 1) costituiscono elementi centrali di un sistema reticolare, comprensivo e dinamico che voglia comunicare con trasparenza le informazioni inerenti alla creazione e alla misura dello shared value, del valore condiviso (Porter e Kramer, 2011; Nicotra, 2014).

È necessario infatti rappresentare il valore dei LNS con la consapevolezza che il suo impatto non riguarda solo la sfera finanziaria.

È altresì importante distinguere il concetto di valutazione dell'impatto (impact) dell'infrastruttura, che è quello che questo studio vuole misurare, dal concetto di valutazione dei risultati (outcomes).

La valutazione dei risultati ha lo scopo di qualificare e quantificare il valore aggiunto del progetto rispetto agli obiettivi prefissati, tenendo conto del modo in cui si è svolto il processo di attuazione e dei cambiamenti che possono essere intervenuti nel contesto di riferimento.

La valutazione di impatto considera, invece, la persistenza nel tempo e la portata dei risultati immediati. Entrambe le valutazioni hanno comunque a che fare con l'efficacia esterna ovvero con il grado di copertura o di soddisfazione dei bisogni da cui il progetto è stato generato.

Tab. 1: Soggetti beneficiari

Imprese	Spin-off e start-up, PMI, grandi imprese che direttamente beneficiano dei servizi offerti daI LNS, e/o godono di effetti indiretti derivanti da commesse o da spillover di conoscenza.
Lavoratori e comunità scientifica	Scienziati e ricercatori che producono conoscenza e sono diretti utilizzatori dei laboratori. Giovani ricercatori, studenti e professionisti che svolgono un periodo di studio presso LNS. La comunità scientifica di riferimento che beneficia degli spillover di conoscenza.
Utenti	Consumatori di beni e servizi prodotti da LNS (o involontariamente generati) e utilizzati a titolo gratuito o dietro pagamento. Visitatori che accedono all'infrastruttura, anche virtualmente attraverso siti web e social network.
Contribuenti	"Finanziatori" indiretti dell'infrastruttura che, pur non beneficiandone direttamente, apprezzano le scoperte scientifiche e il progresso tecnologico generato da LNS

Fonte: Nostra elaborazione

2. Modello di analisi

Nella progettazione e nella realizzazione del modello di stima dell'impatto dei LNS si è dovuto tenere conto dei diversi aspetti in cui si articolano gli effetti di un grande infrastruttura, che ha una portata rilevante a livello regionale e nazionale.

La presenza di LNS nel territorio siciliano genera sviluppo socio-economico attraverso la creazione di posti di lavoro, l'acquisto di beni e servizi, le entrate fiscali, il potere d'acquisto per i redditi connessi all'occupazione direttamente ed indirettamente creata, la nascita di spin-off, lo *spillover* di conoscenze ecc…

Per dimostrare la misura e gli effetti dell'impatto di LNS sul territorio siciliano e nazionale, nelle pagine che seguono, sono analizzate nel dettaglio le variabili sopra accennate, prendendo a riferimento gli anni 2013 - 2023.

A tal proposito, si distinguono e misurano quattro tipologie d'impatto economico: diretto, indiretto, indotto. Ciascuna di queste tipologie coglie un livello dell'effetto economico derivante dall'operare di LNS sul territorio siciliano.

A queste tipologie di impatto, si aggiunge quello sociale.

Il modello di stima dell'indotto generale di LNS si articola quindi sui livelli indicati, che vengono di seguito descritti.

Innanzitutto, *l'impatto diretto* intende misurare l'effetto di LNS attraverso la determinazione dei trasferimenti in denaro sotto forma di salari/stipendi/provvigioni, tasse e profitti reinvestiti negli anni dal 2005 al 2020. Nel dettaglio, le misure dell'impatto diretto sono:

α_1 - Compensi erogati
α_2 - Tasse versate
α_3 - Profitti reinvestiti

La misurazione dell'*impatto indiretto* si lega invece al volume d'affari generato da LNS per i suoi fornitori, distinti per settore.

Questo livello d'impatto misura i trasferimenti in denaro che, negli anni 2005-2020, LNS ha operato a favore dei propri fornitori a monte della filiera produttiva, fornitori di materie prime e servizi, sia in relazione agli investimenti che ai costi di gestione.

L'impatto indiretto è pertanto riconducibile alla liquidità reimmessa da LNSsul territorio siciliano in cambio di controprestazioni ricevute da partner e fornitori locali (fatture pagate da LNS in cambio di controprestazioni nella fornitura);

Nel dettaglio, l'impatto indiretto comprende:

β_1 - *Liquidità reimmessa, a livello locale, nazionale e internazionale, in cambio di controprestazioni per investimento iniziale*

β_2 - *Liquidità reimmessa in cambio di controprestazioni per gestione*

Lo studio intende misurare altresì *l'impatto indotto,* dato da due misure. Da un lato si rilevano le ricadute sul sistema economico derivanti dalla presenza delle interdipendenze settoriali tra i vari settori: per produrre i beni e servizi domandati, ognuno di questi "attiva" i suoi fornitori, generando a sua volta nel tempo nuova domanda di fattori produttivi. Questo determina un effetto moltiplicativo che può essere misurato attraverso le tavole input output.

Dall'altro lato si stimano le spese in consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti LNS. Quest'ultima misura intende cogliere l'effetto sul potere d'acquisto dei lavoratori direttamente connessi all'attività economica generata da LNS e, più in generale, mira anch'essa a dare una misura dell'innesco moltiplicativo che la presenza di LNS produce sull'economia siciliana e italiana.

Nel dettaglio, l'impatto indotto comprende:

γ_1 - *Effetti indotti dagli investimenti*

γ_2 - *Effetti indotti dai costi di gestione*

γ_3 - *Effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori*

Accanto ai livelli di impatto economico, prima rilevati, il progetto è in grado di generare un *impatto sociale* che viene in questo studio misurato in termini economici.

L'impatto sociale nel dettaglio comprende:

δ_1 - *Nuove imprese generate dall'infrastruttura*

Nuove imprese sono state già create e altre se ne creeranno a livello sia locale che nazionale per sfruttare le opportunità che LNS ed il suo indotto generano. L'imprenditorialità che nasce su specifico stimolo di LNS ed il suo impatto di medio-lungo termine sono quindi una componente della *legacy* dell'infrastruttura, in virtù della sua forza propulsiva alla generazione di nuove imprese che si svilupperanno nel tessuto economico siciliano e italiano in generale.

δ_2 - *Valore dei brevetti*

Innovazione tecnologica e attività di ricerca e sviluppo assumono un ruolo di primo piano in economia. Sono strumenti strategici per la concorrenza internazionale: da un lato decisivi per il miglioramento continuo delle produzioni più tradizionali, dall'altro fonte principale per nuove produzioni di beni e di servizi.

Due brevetti sono stati già pubblicati derivanti dall'attività di ricerca svolta in seno a LNS ed altri si stima che verranno pubblicati entro il 2023. E' pertanto importante far emergere il valore economico generato dall'attività brevettuale, che consente un *knowledge spillover* di cui beneficiano le imprese e l'intero territorio regionale e nazionale per l'accresciuta competitività sul mercato.

δ_3 - *Valore delle pubblicazioni scientifiche*

Tra i benefici dei LNS, vi è la possibilità per scienziati e ricercatori di accedere a nuovi dati, elaborarli e contribuire alla creazione di nuova conoscenza che produce un output scientifico, quale una pubblicazione su un journal o una monografia.

Così come per i brevetti, anche nel caso delle pubblicazioni, lo studio rileva il valore sociale ed economico di queste.

δ_4 - *Formazione di capitale umano*

LNS impiega personale scientifico, tecnico (tecnici e ingegneri), amministrativo e di supporto e ospita studenti di dottorato di ricerca, ricercatori postdoc, giovani accademici e altri utenti a breve termine che godono della formazione in termini di nuova conoscenza ed esperienza acquisita che una infrastruttura scientifica è in grado di apportare al loro bagaglio culturale e professionale.

δ_5 - *Servizi al territorio*

LNS mette a disposizione della regione Sicilia, 120 km di fibra ottica collegando Capo Passero a Catania.

δ_6 - *Knowledge spillover nell'ambito della supply chain*

I fornitori di tecnologia coinvolti in prima linea nella progettazione, costruzione e nel funzionamento dei LNS, possono godere di ricadute derivanti proprio dal lavorare con/per un'infrastruttura di ricerca. Le imprese coinvolte nella catena di fornitura LNS affronta la sfida di fornire soluzioni industriali non in commercio per una serie di problemi tecnologici complessi. Tale situazione ha dato e dà alle imprese l'opportunità di collaborare con il personale scientifico e tecnico dei LNS e di acquisire nuove conoscenze e competenze tecnologiche. Il beneficio del learning-by-doing dei fornitori può produrre diverse tipologie di sviluppi, che vanno dai miglioramenti alle attrezzature già esistenti alla realizzazione di processi per la produzione di nuovi strumenti che possono trovare applicazione in altri settori della scienza e dell'industria.

δ_7 - *Attrattività "scientifica" dell'area*

Le area Catania e di Capo Passero e, grazie alla presenza di LNS, godono di un flusso di ricercatori interessati al sito sottomarino, di scolaresche in visita all'area, di studenti dei corsi formativi attivati, di attività congressuali che si ripercuotono sulle spese di alloggio e ristorazione, trasporti, servizi vari e giornali-editoria.

δ_8 - *Rafforzamento dell'immagine di* LNS *e delle sue relazioni internazionali*

L'immagine di LNS viene rafforzata dal progetto stesso sia a livello nazionale che internazionale, con ripercussioni sulla capacità di attrazione di fondi comunitari e non.

δ_9 - *Valore dell'esistenza*

Un ulteriore impatto sul benessere sociale è correlato al potenziale di scoperta dei LNS. La scoperta in sé, oltre al valore di pubblicazioni e brevetti, ha un valore sociale intrinseco e porta un certo numero di nuovi miglioramenti del benessere umano definiti come i "benefici del non uso".

3. Metodologia

L'analisi di impatto è svolta in base alla metodologia rappresentata in Nicotra *et al.* 2017 e di seguito esposta. La metodologia è strutturata secondo un *approccio integrato* utile per la rilevazione delle differenti tipologie di impatto.

L'impatto diretto, come sopraccennato, intende misurare l'effetto dell'infrastruttura attraverso la determinazione dei trasferimenti in denaro sotto forma di salari/stipendi/provvigioni, tasse e profitti reinvestiti negli anni dal 2013 al 2023.

La natura dei dati ricavati è pertanto di tipo contabile-gestionale, così come le stime ottenute.

Similmente, l'impatto indiretto deriva da dati contabili-gestionali e mira a rilevare la liquidità reimmessa nel sistema in cambio di controprestazioni sia per gli investimenti realizzati che per la gestione dell'infrastruttura. Tali dati sono distinti non solo per settore ma anche per localizzazione del fornitore (locale, nazionale e internazionale), in modo tale da avere un dettaglio sulle ripercussioni economiche generate dai LNS a differenti livelli geografici.

Per la rilevazione dell'impatto indotto, dai riferimenti contabili si passa a rilevazioni di tipo macro-economico, così come suggerito dal modello di modello di Leontief (1966) costruito sulla base delle tavole Input-Output (I-O).

Queste ultime costituiscono uno degli strumenti più idonei per la valutazione degli effetti indotti della realizzazione di un progetto, sotto forma di stimolo all'attività produttiva e di incremento del reddito.

Nel modello I-O, le vendite di ciascun settore produttivo a ciascuno degli altri settori sono descritte nella 'matrice delle transazioni' o 'tavola delle interdipendenze settoriali' o 'matrice input-output' che registra i valori dei flussi di prodotti da ciascun settore a ciascun altro (compreso l'aggregato famiglie).

Per le analisi del sistema produttivo, la tavola dei flussi viene trasformata in una tavola dei coefficienti, ipotizzando che in ciascuna attività produttiva la quantità di input assorbita sia, relativamente ad ogni input, strettamente proporzionale al volume dell'output conseguibile (ipotesi di tecnologia lineare).

La diffusione degli effetti di uno shock idiosincratico, cioè specifico ad alcuni settori dell'economia regionale (nel caso in considerazione, l'investimento e la gestione dei LNS) sul totale dell'economia considerata, avviene attraverso un processo di moltiplicazione keynesiano. Una delle caratteristiche dei modelli input-output è che il valore dei moltiplicatori dipende in maniera cruciale dal settore in cui si realizza lo shock di domanda iniziale.

Il primo passo nell'analisi consiste pertanto nell'identificazione e disaggregazione di tutti i flussi di spesa dei LNS tra i differenti settori dell'economia.

I LNS danno luogo ad un output, acquistando e combinando insieme alcuni input provenienti dalle famiglie o da altri settori produttivi ai quali giungono dei flussi di ricavi. A loro volta questi settori, attraverso i flussi in uscita, generano ricavi in altri settori.

La tecnica I-O si caratterizza per la sua trasparenza: attraverso tale analisi, infatti, è possibile ricavare i moltiplicatori, nonché quantificare l'impatto di un dato evento sull'economia del territorio considerato. Alcuni limiti metodologici impongono tuttavia una cauta lettura dei risultati ottenuti. Le assunzioni e semplificazioni su cui poggia il modello possono, infatti, indurre a sovrastimare gli effetti indotti sul totale dell'economia derivanti da uno shock che colpisce uno o più settori della regione.

In questo studio, i moltiplicatori per ciascun settore "fornitore" dei LNS sono stati ricavati dalle tabelle I-O del sistema italiano elaborate dall'ISTAT. A partire da questi, è quantificato l'impatto indotto nel 2023 generato dagli investimenti dei LNS effettuati tra il 2013 e il 2023, dalla sua gestione (2013-2023) e dai consumi effettuati nello stesso periodo dalle famiglie il cui salario è collegato ai LNS.

Infine, l'impatto sociale è stato stimato sulla base dei dati di input forniti da INFN e contabilizzato in termini monetari. Per l'elaborazione di questo si è proceduto con il riadattamento della metodologia utilizzata da Florio et al (2015) agli scopi e alla natura di indagine del presente lavoro. Ciascuna tipologia di impatto sociale segue delle differenti regole di stima e misurazione il cui dettaglio è fornito in seguito.

4. Misurazione degli impatti diretto, indiretto e indotto

Di seguito verranno riportati i risultati delle misurazioni dell'impatto diretto, indiretto e indotto.

α_1 Impatto diretto - Compensi erogati

I compensi erogati a dipendenti e collaboratori sono stati rilevati dalle informazioni contabili fornite dai LNS con riferimento agli anni 2013-2017. La stima degli anni 2018-2023 considera l'assunzione di 4 tecnologi negli anni 2019 - 2021. L'impatto 2023 dei compensi erogati a dipendenti e collaboratori, così calcolato, è pari a € 27.847.269,00. Per il dettaglio si vedano le tabelle 2 e 3

Tab. 2: Compensi erogati LNS (anni 2013-2019; Valori in Euro)

	2013	2014	2015	2016	2017	2018	2019
Dirigente Di Ricerca	308.343,60	308.343,60	308.343,60	308.343,60	308.343,60	308.343,60	308.343,60
Dirigente Tecnologo	143.696,40	143.696,40	143.696,40	143.696,40	143.696,40	143.696,40	143.696,40
Primo Ricercatore	605.541,00	605.541,00	605.541,00	605.541,00	605.541,00	605.541,00	605.541,00
Primo Tecnologo	140.317,20	140.317,20	140.317,20	140.317,20	140.317,20	140.317,20	140.317,20
Ricercatore	447.768,60	447.768,60	447.768,60	447.768,60	447.768,60	447.768,60	447.768,60
Tecnologo	384.496,20	384.496,20	384.496,20	384.496,20	384.496,20	384.496,20	443.649,46
Funzionario Amm	82.104,00	82.104,00	82.104,00	82.104,00	82.104,00	82.104,00	82.104,00
Operatore Amministr	229.887,00	229.887,00	229.887,00	229.887,00	229.887,00	229.887,00	229.887,00
Collaboratore Amm	151.773,00	151.773,00	151.773,00	151.773,00	151.773,00	151.773,00	151.773,00
C.T.E.R.	1.405.665,00	1.405.665,00	1.405.665,00	1.405.665,00	1.405.665,00	1.405.665,00	1.405.665,00
TOTALE	**2.495.940,00**	**2.495.941,00**	**2.495.942,00**	**2.495.943,00**	**2.495.944,00**	**2.495.945,00**	**2.555.099,26**

Fonte: Nostra elaborazione su dati LNS

Tab. 3: Compensi erogati LNS (stima anni 2020-Impatto; Valori in Euro)

	2020	2021	2022	2023	IMPATTO 2023
Dirigente Di Ricerca	308.343,60	308.343,60	308.343,60	308.343,60	**3.391.779,60**
Dirigente Tecnologo	143.696,40	143.696,40	143.696,40	143.696,40	**1.580.660,40**
Primo Ricercatore	605.541,00	605.541,00	605.541,00	605.541,00	**6.660.951,00**
Primo Tecnologo	140.317,20	140.317,20	140.317,20	140.317,20	**1.543.489,20**
Ricercatore	447.768,60	447.768,60	447.768,60	447.768,60	**4.925.454,60**
Tecnologo	443.649,46	473.226,09	502.802,72	473.226,09	**4.643.531,02**
Funzionario Amm	82.104,00	82.104,00	82.104,00	82.104,00	**903.144,00**
Operatore Amministr	229.887,00	229.887,00	229.887,00	229.887,00	**2.528.757,00**
Collaboratore Amm	151.773,00	151.773,00	151.773,00	151.773,00	**1.669.503,00**
C.T.E.R.	1.405.665,00	1.405.665,00	1.405.665,00	1.405.665,00	**15.462.315,00**
TOTALE	**2.555.100,26**	**2.584.677,89**	**2.614.255,52**	**2.584.679,89**	**27.847.269,82**

Fonte: Nostra elaborazione su dati LNS

α_2 Impatto diretto - Tasse versate

Il regime agevolato di tassazione delle attività di ricerca finanziata e lo status giuridico dell'INFN, con riferimento ai LNS, determina imposte risibili. La generazione di significativi flussi per tassazione potrebbe derivare in futuro da una notevole attività commerciale per la valorizzazione dei risultati della ricerca effettuata presso i LNS. Tuttavia, fino al 2023 questi possono considerarsi irrilevanti. Pertanto non viene registrato in questa fase alcun impatto diretto determinato da tasse versate in Sicilia e in Italia.

α_3 Impatto diretto - Profitti reinvestiti.

Nel periodo 2013-2023 si registrano ricavi da attività commerciale.

I LNS, attraverso la sala di irraggiamento per la proton-terapia CATANA trattano i tumori della regione oculare, con un rilevante impatto sulla salute della popolazione non solo locale ma anche nazionale. Dal 2002 ad oggi sono stati trattati più di 300 pazienti. Per l'attività di protonterapia in media si ha un ricavo annuo di € 60.000. La Convenzione per lo svolgimento di attività terapeutiche con fasci di protoni stipulata fra l'INFN e l'Azienda Ospedaliero-Universitaria "Policlinico Vittorio Emanuele" stabilisce che all'INFN viene corrisposta la somma di 1.500 € per paziente. Si trattano in media 40 pazienti l'anno, che è il numero medio di pazienti trattati in 3 sessioni.

Inoltre i LNS svolge un'attività di irraggiamento di componenti elettronici da inviare nello spazio. Il costo richiesto alle ditte che fruiscono di tale servizio è di 6800 € per ogni BTU di fascio on target. Il ricavo medio annuo di € 81.600 corrispondenti al totale di 12 BTU indicati nel paragrafo precedente.

Il valore stimato dei ricavi, sia di quelli effettivi che di quelli stimati per il periodo 2018-223 viene reinvestito per l'attività di potenziamento dei LNS. L'impatto economico di tale valore è pertanto registrato all'interno della sezione "β1 Impatto indiretto - Liquidità reimmessa, a livello locale, nazionale e internazionale, in cambio di controprestazioni per investimento".

β_1 Impatto indiretto - Liquidità reimmessa, a livello locale, nazionale e internazionale, in cambio di controprestazioni per investimento

Il vettore dei costi di investimento è stato calcolato a partire dalle informazioni fornite da LNS relativamente ai lavori già svolti negli anni 2005 -2015 sui siti di Catania e Capo Passero e a quelli previsti nel piano d'investimento 2017 - 2020 per il potenziamento dell'infrastruttura. Degli investimenti è stato fornito il dettaglio settoriale (in base ai codici di classificazione settoriale Ateco) e territoriale (fornitori distinti in locali, nazionali e internazionali).

Il Progetto ha evidenziato la capacità di coinvolgere PMI siciliane per la realizzazione di componenti tecnologicamente innovative dell'osservatorio, quali sistemi di trasmissione dati su fibre ottiche, elettronica per gestione e controllo di complesse reti di distribuzione segnali, strutture meccaniche per ambienti marini, cavi e connettori per ambienti marini. Pertanto sono stati

interessati i comparti locali della meccanica, elettronica (produzione e progettazione), Information Technology, servizi (assemblaggio e costruzione sistemi).

In totale si evidenzia un impatto indiretto generato dalla liquidità reimmessa in cambio di controprestazioni per l'investimento pari a € 61.230.740,90 a livello locale, nazionale e internazionale (Tab. 4 e 5).

Tab. 4: Liquidità reimmessa in cambio di controprestazioni per investimenti LNS (anni 2013-2019; Valori in Euro)

	2013	2014	2015	2016	2017	2018	2019
Impianti Attrezzature Macchinari	2.695.572,36	3.940.564,28	1.859.108,55	2.902.452,63	3.156.882,86	7.560.000,00	18.716.666,67
Altre Immobilizzazioni Tecniche -Costruzione Apparati-	120.426,00	858.426,00	1.414.789,45	1.200.000,00	2.000.000,00	1.000.000,00	2.850.000,00
Mobili E Macchine Ufficio	8.619,50	10.200,00	11.015,00	5.800,00	8.908,63	8.908,63	8.908,63
TOTALE	**2.824.617,86**	**4.809.190,28**	**3.284.913,00**	**4.108.252,63**	**5.165.791,49**	**8.568.908,63**	**21.575.575,29**

Fonte: Nostra elaborazione su dati LNS

Tab. 5: Liquidità reimmessa in cambio di controprestazioni per investimenti LNS (stima anni 2020-Impatto; Valori in Euro)

	2020	2021	2022	2023	IMPATTO
Impianti Attrezzature Macchinari	14.806.666,67	6.466.666,67	2.910.916,14	2.910.916,14	**53.371.832,27**
Altre Immobilizzazioni Tecniche -Costruzione Apparati-	1.000.000,00	1.000.000,00	1.000.000,00	1.000.000,00	**7.850.000,00**
Mobili E Macchine Ufficio	8.908,63	8.908,63	8.908,63	8.908,63	**8.908,63**
TOTALE	**15.815.575,29**	**7.475.575,29**	**3.919.824,76**	**3.919.824,76**	**61.230.740,90**

Fonte: Nostra elaborazione su dati LNS

β_2 Impatto indiretto - Liquidità reimmessa in cambio di controprestazioni per gestione

Il vettore dei costi di gestione è stato calcolato a partire dalle informazioni fornite dai LNS in base alle fatture annuali dal 2013 al 2017, di cui è stato fornito il dettaglio settoriale (in base ai codici di classificazione settoriale Ateco), e delle previsioni realizzate nel progetto di potenziamento POTLNS.

Si evidenzia che la liquidità immessa nel sistema, complessivamente dal 2013 al 2023, in cambio di controprestazioni per gestione ha un impatto locale per via della localizzazione nell'area siciliana dei fornitori ed è quantificabile in € 202.213.444,97. Per il dettaglio si vedano le tabelle 6 e 7.

Tab. 6: Liquidità reimmessa in cambio di controprestazioni per gestione LNS (anni 2013-2019; Valori in Euro)

	2013	2014	2015	2016	2017	2018	2019
Accertamenti Sanitari	13.000,00	11.754,90	10.296,89	13.000,00	12.393,50	12.089,06	12.089,06
Altre Spese per Servizi	5.773.423,01	3.465.159,69	1.273.633,10	1.036.939,17	1.619.758,98	2.633.782,79	2.633.782,79
Altri Materiali di Consumo	132.013,95	124.855,94	66.459,48	169.886,97	5.201.707,85	1.138.984,84	1.138.984,84
Altri Materiali di Consumo Attività Laboratorio	13.849.277,00	16.005.902,04	1.448.284,13	1.023.840,78	1.266.265,60	6.718.713,91	6.718.713,91
Altri Tributi	53.781,64	48.560,00	50.000,00	-	-	50.780,55	50.780,55
Attività Sociali, Culturali, Ricreative	1.840,00	2.340,00	1.840,00	1.840,00	1.840,00	1.940,00	1.940,00
Buoni Pasto e Mensa	285.600,00	285.600,00	122.251,83	283.571,01	205.600,00	236.524,57	236.524,57
Combustibile Riscaldamento E Impianti	144.967,99	200.000,00	196.839,63	165.000,00	80.000,00	157.361,52	157.361,52
Energia Elettrica Impianti di Ricerca	-	-	1.544.413,72	2.440.000,00	2.440.000,00	2.141.471,24	2.141.471,24
Formazione del Personale	23.000,00	44.500,00	26.000,00	-	-	31.166,67	31.166,67
Licenze Software	61.310,44	39.302,87	32.775,46	114.911,31	24.474,95	54.555,01	54.555,01
Linee Trasmissione Dati Ricerca	10.911,68	-	-	-	-	10.911,68	10.911,68
Manutenzione Ordinaria e Riparazioni di Apparecchiature	1.880.693,47	1.708.873,46	1.021.392,69	862.433,96	841.801,80	1.263.039,08	1.263.039,08
Manutenzione Ordinaria e Riparazioni di Immobili	541.982,35	1.222.059,04	2.723.551,62	501.687,60	173.618,44	1.032.579,81	1.032.579,81
Materiale Bibliografico	98.500,00	108.492,74	880,47	10.849,94	-	43.744,63	43.744,63
Materiale di Consumo			66.121,11	9.063,79	30.910,99	35.365,30	35.365,30
Materiale di Consumo Attività Laboratorio	1.653.224,35	469.570,97	815.267,23	562.821,59	521.928,58	804.562,54	804.562,54
Missioni Formazione	25.100,00	30.200,00	27.500,00	-	-	27.600,00	27.600,00
Missioni non Soggette a Vincolo	218.084,44	966.306,04	979.205,89	-	76.674,56	560.067,73	560.067,73
Noleggi e Spese Accessorie Attività Laboratorio	2.823,54	7.000,00	-	6.733,96	7.000,00	4.711,50	4.711,50
Oneri e Commissioni Bancarie	-	1.000,00	2.000,00	2.000,00	2.000,00	1.750,00	1.750,00
Organizzazione Manifestazioni e Convegni	1.000,00	108.481,82	175.819,20	207.218,34	102.199,99	118.943,87	118.943,87
Partite in Conto Sospesi	-	-	-	-	-	-	-
Premi di Assicurazione R.C.T.	2.588,07	2.000,00	-	-	-	917,614	917,614
Programma di Ospitalità Studenti		6.000,00	6.000,00	-	-	6.000,00	6.000,00
Pubblicazioni e Riviste Scientifiche	17.120,55	20.789,38	118.103,87	42.056,16	57.299,08	51.073,81	51.073,81
Pubblicazioni, Giornali e Riviste Generiche	2.000,00	9.000,00	21.049,55	66.518,52	44.089,36	28.531,49	28.531,49
Ritenute Erariali	-	-	-	60.000,00	123.000,00	36.600,00	36.600,00
Seminari	39.280,00	18.474,35	17.235,00	13.500,00	37.400,00	25.177,87	25.177,87
Servizi Pulizie	342.608,00	350.458,85	341.460,98	277.701,04	267.000,00	315.845,77	315.845,77
Servizi Trasporti E Facchinaggio Attività Laboratorio	8.200,00	49.154,80	55.136,21	48.778,47	28.682,58	37.990,41	37.990,41
Servizi Vigilanza	296.274,11	301.344,87	299.335,54	300.520,77	264.000,00	292.295,06	292.295,06
Spese Postali	13	2.000,00	11,65	1.000,00	100	624,93	624,93
Spese Soggiorno Ospiti Ricercatori	113.570,10	95.474,99	83.371,92	1.169.619,56	1.185.978,72	529.603,06	529.603,06
Studi, Consulenze e Indagini	29.495,00	29.590,00	29.637,50	-	-	29.574,17	29.574,17
Studi, Consulenze e Indagini Per Attività Di Ricerca	192.500,00	78.867,95	-	154.590,00	298.335,64	181.073,40	181.073,40
Trattamento Missioni	777.368,88	12.400,00	12.400,00	-	-	267.389,63	267.389,63
Utenza Idrica	11.000,00	11.000,00	1.349,58	8.500,00	7.027,48	7.775,41	7.775,41
Utenze Telefoniche	33.000,25	37.396,08	17.000,00	52.408,22	34.000,00	34.760,91	34.760,91
TOTALE	**26.635.551,82**	**25.873.910,78**	**11.586.624,25**	**9.606.991,16**	**14.955.088,10**	**18.925.879,81**	**18.925.879,81**

Fonte: Nostra elaborazione su dati LNS

Tab. 7: Liquidità reimmessa in cambio di controprestazioni per gestione LNS (stima anni 2020-Impatto;Valori in Euro)

	2020	2021	2022	2023	Impatto 2023
Accertamenti Sanitari	12.089,05	12.089,05	12.089,05	12.089,05	**132.979,63**
Altre Spese Per Servizi	2.633.782,79	2.633.782,79	2.633.782,79	2.633.782,79	**28.971.610,69**
Altri Materiali Di Consumo	1.138.984,83	1.138.984,83	1.138.984,83	1.138.984,83	**12.528.833,21**
Altri Materiali Di Consumo Attività Laboratorio	6.718.713,91	6.718.713,91	6.718.713,91	6.718.713,91	**73.905.853,01**
Altri Tributi	50.780,54	50.780,54	50.780,54	50.780,54	**457.024,92**
Attività Sociali, Culturali, Ricreative	1.940,00	1.940,00	1.940,00	1.940,00	**21.340,00**
Buoni Pasto E Mensa	236.524,56	236.524,56	236.524,56	236.524,56	**2.601.770,24**
Combustibile Riscaldamento E Impianti	157.361,52	157.361,52	157.361,52	157.361,52	**1.730.976,76**
Energia Elettrica Impianti Di Ricerca	2.141.471,24	2.141.471,24	2.141.471,24	2.141.471,24	**19.273.241,16**
Formazione Del Personale	31.166,66	31.166,66	31.166,66	31.166,66	**280.500,00**
Licenze Software	54.555,00	54.555,00	54.555,00	54.555,00	**600.105,06**
Linee Trasmissione Dati Ricerca	10.911,68	10.911,68	10.911,68	10.911,68	**76.381,76**
Manutenzione Ordinaria E Riparazioni Di Apparecchiature	1.263.039,07	1.263.039,07	1.263.039,07	1.263.039,07	**13.893.429,83**
Manutenzione Ordinaria E Riparazioni Di Immobili	1.032.579,81	1.032.579,81	1.032.579,81	1.032.579,81	**11.358.377,91**
Materiale Bibliografico	43.744,63	43.744,63	43.744,63	43.744,63	**481.190,93**
Materiale Di Consumo	35.365,29	35.365,29	35.365,29	35.365,29	**318.287,67**
Materiale Di Consumo Attività Laboratorio	804.562,54	804.562,54	804.562,54	804.562,54	**8.850.187,98**
Missioni Formazione	27.600,00	27.600,00	27.600,00	27.600,00	**248.400,00**
Missioni Non Soggette a Vincolo	560.067,73	560.067,73	560.067,73	560.067,73	**5.600.677,32**
Noleggi E Spese Accessorie Attività Laboratorio	4.711,50	4.711,50	4.711,50	4.711,50	**51.826,50**
Oneri E Commissioni Bancarie	1.750,00	1.750,00	1.750,00	1.750,00	**17.500,00**
Organizzazione Manifestazioni e Convegni	118.943,87	118.943,87	118.943,87	118.943,87	**1.308.382,57**
Partite In Conto Sospesi	-	-	-	-	**-**
Premi Di Assicurazione R.C.T.	917,61	917,61	917,61	917,61	**10.093,75**
Programma Di Ospitalità Studenti	6.000,00	6.000,00	6.000,00	6.000,00	**48.000,00**
Pubblicazioni E Riviste Scientifiche	51.073,80	51.073,80	51.073,80	51.073,80	**561.811,88**
Pubblicazioni, Giornali E Riviste Generiche	28.531,48	28.531,48	28.531,48	28.531,48	**313.846,34**
Ritenute Erariali	36.600,00	36.600,00	36.600,00	36.600,00	**402.600,00**
Seminari	25.177,87	25.177,87	25.177,87	25.177,87	**276.956,57**
Servizi Pulizie	315.845,774	315.845,77	315.845,77	315.845,77	**3.474.303,51**
Servizi Trasporti E Facchinaggio Attività Laboratorio	37.990,41	37.990,41	37.990,41	37.990,41	**417.894,53**
Servizi Vigilanza	292.295,05	292.295,05	292.295,05	292.295,05	**3.215.245,63**
Spese Postali	624,93	624,93	624,93	624,93	**6.874,23**
Spese Soggiorno Ospiti Ricercatori	529.603,05	529.603,05	529.603,05	529.603,05	**5.825.633,63**
Studi, Consulenze E Indagini	29.574,16	29.574,16	29.574,16	29.574,16	**266.167,50**
Studi, Consulenze E Indagini Per Attività Di Ricerca	181.073,39	181.073,39	181.073,39	181.073,39	**1.810.733,97**
Trattamento Missioni	267.389,62	267.389,62	267.389,62	267.389,62	**2.406.506,64**
Utenza Idrica	7.775,41	7.775,41	7.775,41	7.775,41	**85.529,53**
Utenze Telefoniche	34.760,91	34.760,91	34.760,91	34.760,91	**382.370,01**
TOTALE	**18.925.879,81**	**18.925.879,81**	**18.925.879,81**	**18.925.879,81**	**202.213.444,97**

Fonte: Nostra elaborazionesu dati LNS

γ_1 Impatto indotto - Effetti indotti dagli investimenti

Come sopra indicato, facendo riferimento alle tavole Input-Output elaborate dall'ISTAT per il sistema italiano, per ogni anno e per ciascuna voce di spesa di investimento relativa ad uno specifico settore, si rileva il "moltiplicatore" di impatto, attivo per il tempo che separa l'anno in cui si ha la suddetta spesa dal 2023, anno su cui si calcola l'impatto.

Moltiplicando ciascuna voce di spesa per il "moltiplicatore" individuato, si stima il totale di impatto indotto degli investimenti realizzati da fornitori locali, nazionali e internazionali (Tab. 8 e 9).

Tab. 8: Impatto indotto - Effetti indotti dagli investimenti (anni 2013-2019; Valori in Euro)

	Impatto 2013 su 2023	Impatto 2014 su 2023	Impatto 2015 su 2023	Impatto 2016 su 2023	Impatto 2017 su 2023	Impatto 2018 su 2023	Impatto 2019 su 2023
Edilizia	23.981,01	40.830,03	27.856,06	34.714,73	43.392,65	71.036,25	173.683,38
Progettazione	123.577,03	210.402,07	143.714,94	179.325,23	224.324,40	369.748,41	914.804,39
Elettronica e Ottica	510.125,99	868.539,76	592.269,81	739.485,47	923.597,72	1.519.267,50	3.734.732,08
Settore Elettrico	194.616,17	330.872,29	225.673,52	281.415,31	350.668,03	574.116,88	1.404.569,95
Installazione	353.529,17	601.918,26	410.679,82	513.038,59	642.547,60	1.061.687,78	2.639.987,39
Macchinari e Apparecchiature	804.451,17	1.369.657,39	934.229,26	1.165.100,45	1.452.178,21	2.375.301,47	5.782.254,18
TOTALE	**2.010.280,53**	**3.422.219,80**	**2.334.423,42**	**2.913.079,77**	**3.636.708,63**	**5.971.158,29**	**14.650.031,38**

Fonte: Nostra elaborazione su dati LNS attraverso matrici I-O ISTAT

Tab. 9: Impatto indotto - Effetti indotti dagli investimenti (stima anni 2020-Impatto; Valori in Euro)

	Impatto 2020 su 2023	Impatto 2021 su 2023	Impatto 2022 su 2023	IMPATTO
Edilizia	118.933,13	47.843,68	16.345,67	**598.616,59**
Progettazione	642.903,14	273.606,06	102.895,40	**3.185.301,07**
Elettronica e Ottica	2.585.846,56	1.060.784,13	363.367,76	**12.898.016,79**
Settore Elettrico	956.842,31	379.759,22	141.505,67	**4.840.039,36**
Installazione	1.882.053,46	829.938,37	345.728,54	**9.281.108,99**
Macchinari e Apparecchiature	3.915.936,44	1.530.997,82	481.354,48	**19.811.460,87**
TOTALE	**10.102.515,03**	**4.122.929,28**	**1.451.197,52**	**50.614.543,66**

Fonte: Nostra elaborazione su dati LNS attraverso matrici I-O ISTAT

γ_2 *Impatto indotto - Effetti indotti dai costi di gestione*

Le tavole Input-Output (I-O) vengono altresì utilizzate per la valutazione degli effetti indotti dai costi di gestione dei LNS per ciascun anno di riferimento (Tab. 10 e 11).

Tab. 10: Impatto indotto - Effetti indotti dalla gestione dei LNS (anni 2013-2019;Valori in Euro)

	Impatto 2013 su 2023	Impatto 2014 su 2023	Impatto 2015 su 2023	Impatto 2016 su 2023	Impatto 2017 su 2023	Impatto 2018 su 2023	Impatto 2019 su 2023
Accertamenti Sanitari	11.544,00	10.438,35	9.143,64	11.531,00	10.968,25	10.638,37	10.517,48
Altre Spese per Servizi	5.167.213,59	3.097.852,76	1.137.354,36	924.949,74	1.441.585,49	2.330.897,77	2.301.926,16
Altri Materiali di Consumo	67.063,09	63.426,82	33.761,42	85.962,81	2.616.459,05	566.075,46	548.990,69
Altri Materiali di Consumo Attività Laboratorio	7.035.432,72	8.130.998,24	735.728,34	518.063,43	636.931,60	3.339.200,81	3.238.420,10
Altri Tributi	48.080,79	43.412,64	44.650,00	-	-	44.940,78	44.382,20
Attività Sociali, Culturali, Ricreative	1.604,48	2.040,48	1.602,64	1.600,80	1.595,28	1.666,46	1.635,42
Buoni Pasto e Mensa	241.332,00	245.616,00	105.014,32	243.020,36	175.376,80	199.390,21	194.423,19
Combustibile Riscaldamento e Impianti	85.966,02	118.600,00	116.529,06	97.680,00	46.800,00	92.056,49	90.325,51
Energia Elettrica Impianti di Ricerca			1.061.012,23	1.671.400,00	1.659.200,00	1.434.785,73	1.394.097,78
Formazione del Personale	22.402,00	43.343,00	25.324,00	-	-	30.325,17	30.262,83
Licenze Software	51.807,32	33.210,93	27.695,26	96.870,23	20.558,96	45.444,32	44.571,44
Linee Trasmissione Dati Ricerca	8.652,96	-	-	-	-	8.565,67	8.423,82
Manutenzione Ordinaria e Riparazioni di Apparecchiature	1.681.339,96	1.527.732,87	912.103,67	769.291,09	749.203,60	1.117.789,58	1.103.896,15
Manutenzione Ordinaria e Riparazioni di Immobili	484.532,22	1.092.520,78	2.432.131,60	447.505,34	154.520,41	913.833,13	902.474,75
Materiale Bibliografico	78.110,50	86.034,74	698,21	8.604,00	-	34.339,53	33.770,85
Materiale di Consumo			33.589,52	4.586,28	15.548,23	-	-
Materiale di Consumo Attività Laboratorio	839.837,97	238.542,05	414.155,75	284.787,72	262.530,08	399.867,58	387.799,15
Missioni Formazione	21.209,50	25.488,80	23.182,50	-	-	22.770,00	22.080,00
Missioni non Soggette a Vincolo	184.281,35	815.562,30	825.470,57	-	64.099,93	462.055,88	448.054,19
Noleggi e Spese Accessorie Attività Laboratorio	2.236,24	5.544,00	-	5.319,83	5.502,00	3.660,84	3.566,61
Oneri e Commissioni Bancarie		893	1.784,00	1.762,00	1.776,00	1.541,75	-
Organizzazione Manifestazioni e Convegni	845	91.558,66	148.215,59	174.270,62	85.439,19	98.128,69	95.155,10
Premi di Assicurazione R.C.T.	2.311,15	1.786,00	-	-	-	808,42	792,82
Programma di Ospitalità Studenti		5.064,00	5.058,00	-	-	4.950,00	4.800,00
Pubblicazioni e Riviste Scientifiche	13.576,60	16.485,98	93.656,37	33.350,53	45.323,57	40.092,94	39.428,98
Pubblicazioni, Giornali e Riviste Generiche	1.586,00	7.137,00	16.692,29	52.749,19	34.874,68	22.397,22	22.026,31
Ritenute Erariali	-	-	-	54.180,00	110.823,00	32.830,20	32.500,80
Seminari	38.258,72	17.994,02	16.786,89	13.149,00	36.427,60	24.498,07	24.447,71
Servizi Pulizie	278.197,70	284.572,59	276.924,85	224.382,44	214.134,00	249.518,16	240.674,48
Servizi Trasporti e Facchinaggio Attività Laboratorio	6.929,00	41.486,65	46.479,83	41.022,69	23.978,64	31.342,09	30.392,33
Servizi Vigilanza	240.574,58	244.692,03	242.761,12	242.820,78	211.728,00	230.913,10	222.728,83
Spese Postali	11,14	1.714,00	9,98	855	85,2	528,07	518,69
Spese Soggiorno Ospiti Ricercatori	95.966,73	80.580,89	70.282,53	983.650,05	991.478,21	436.922,52	423.682,45
Studi, Consulenze e Indagini	25.808,13	25.891,25	25.932,81	-	-	25.522,51	25.078,89
Studi, Consulenze e Indagini per Attività di Ricerca	168.437,50	69.009,46	-	134.957,07	259.552,01	156.266,34	153.550,24
Trattamento Missioni	656.876,70	10.664,00	10.651,60	-	-	225.409,46	219.794,27
Utenza Idrica	8.921,00	8.921,00	1.093,16	6.859,50	5.636,04	6.142,58	5.932,64
Utenze Telefoniche	26.763,20	30.328,22	13.770,00	42.293,43	27.268,00	27.461,12	26.522,57
Totale	**14.985.081,65**	**14.495.227,61**	**6.642.748,74**	**4.876.478,80**	**7.513.199,44**	**10.169.949,50**	**9.948.118,39**

Fonte: Nostra elaborazione su dati LNS attraverso matrici I-O ISTAT

Tab. 11: Impatto indotto - Effetti indotti dalla gestione dei LNS (stima anni 2019-Impatto; Valori in Euro)

	Impatto 2020 su 2023	**Impatto 2021 su 2023**	**Impatto 2022 su 2023**	**IMPATTO 2023**
Accertamenti Sanitari	10.239,43	9.610,80	7.869,98	**102.501,30**
Altre Spese per Servizi	2.238.715,37	2.088.589,75	1.659.283,16	**22.388.368,16**
Altri Materiali di Consumo	512.543,18	432.814,24	271.078,39	**5.198.175,14**
Altri Materiali di Consumo Attività Laboratorio	3.023.421,26	2.553.111,29	1.599.053,91	**30.810.361,70**
Altri Tributi	43.163,46	40.268,97	31.991,74	**340.890,59**
Attività Sociali, Culturali, Ricreative	1.563,64	1.389,04	940,9	**15.639,14**
Buoni Pasto e Mensa	183.306,54	158.944,51	112.822,22	**1.859.246,15**
Combustibile Riscaldamento e Impianti	86.706,20	78.523,40	57.436,96	**870.623,64**
Energia Elettrica Impianti di Ricerca	1.295.590,10	1.087.867,39	773.071,12	**10.377.024,34**
Formazione del Personale	30.107,00	29.701,83	26.398,17	**237.864,00**
Licenze Software	42.607,46	37.970,28	26.186,40	**426.922,61**
Linee Trasmissione Dati Ricerca	8.107,38	7.387,21	5.641,34	**46.778,37**
Manutenzione Ordinaria e Riparazioni di Apparecchiature	1.073.583,21	1.001.589,99	795.714,62	**10.732.244,76**
Manutenzione Ordinaria e Riparazioni di Immobili	877.692,84	818.835,79	650.525,28	**8.774.572,14**
Materiale Bibliografico	32.502,26	29.615,11	22.615,97	**326.291,20**
Materiale di Consumo	-	-	-	**53.724,03**
Materiale di Consumo Attività Laboratorio	362.053,14	305.733,77	191.485,89	**3.686.793,10**
Missioni Formazione	20.534,40	17.112,00	9.825,60	**162.202,80**
Missioni non Soggette a Vincolo	416.690,39	347.241,99	199.384,11	**3.762.840,71**
Noleggi E Spese Accessorie Attività Laboratorio	3.354,59	2.888,15	1.908,16	**33.980,41**
Oneri e Commissioni Bancarie	-	-	-	**7.756,75**
Organizzazione Manifestazioni e Convegni	88.494,24	73.745,20	42.344,02	**898.196,30**
Premi di Assicurazione R.C.T.	752,44	643,25	363,38	**7.457,45**
Programma di Ospitalità Studenti	4.464,00	3.720,00	2.136,00	**30.192,00**
Pubblicazioni e Riviste Scientifiche	37.947,84	34.576,97	26.405,16	**380.844,94**
Pubblicazioni, Giornali e Riviste Generiche	21.198,89	19.315,82	14.750,78	**212.728,18**
Ritenute Erariali	31.768,80	30.048,60	26.059,20	**318.210,60**
Seminari	24.321,82	23.994,51	21.325,66	**241.203,99**
Servizi Pulizie	221.723,73	182.558,86	100.123,11	**2.272.809,92**
Servizi Trasporti e Facchinaggio Attività Laboratorio	28.264,87	23.554,06	13.524,59	**286.974,73**
Servizi Vigilanza	205.191,13	168.946,54	92.657,53	**2.103.013,65**
Spese Postali	496,82	448,7	334,34	**5.001,94**
Spese Soggiorno Ospiti Ricercatori	394.024,68	328.353,90	188.538,69	**3.993.480,64**
Studi, Consulenze e Indagini	24.043,80	21.648,29	15.526,44	**189.452,11**
Studi, Consulenze e Indagini per Attività di Ricerca	147.212,67	132.545,73	95.063,53	**1.316.594,55**
Trattamento Missioni	207.226,96	179.685,83	127.544,85	**1.637.853,67**
Utenza Idrica	5.489,44	4.540,84	2.736,95	**56.273,14**
Utenze Telefoniche	24.541,20	20.300,37	12.235,84	**251.483,96**
Totale	**9.459.849,34**	**8.376.219,61**	**6.040.630,15**	**€ 114.416.572,82**

Fonte: Nostra elaborazione su dati LNS attraverso matrici I-O ISTAT

Il totale è di € 114.416.572,82.

γ_3 Impatto indotto - Effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori

Tale effetto è relativo ai consumi, al netto dei risparmi, di tutte le famiglie siciliane il cui salario e stipendio è direttamente riconducibile ai LNS.

Per misurare il valore della spesa in consumi effettuata dai dipendenti dei LNS, occorre considerare i compensi direttamente erogati dai LNS al netto del valore del risparmio medio delle famiglie italiane negli anni considerati, rilevato dall'ISTAT.

Dai dati ISTAT emerge altresì che la spesa delle famiglie italiane è in media così distribuita come riportato in Tab. 12.

Tab. 12: Distribuzione spesa famiglie italiane per settori

Settore	% Consumi
Alimentari e bevande	17,10%
Abbigliamento e calzature	5,70%
Abitazione ed energia	31,90%
Arredamenti ecc.	5,00%
Sanità	3,10%
Trasporti e comunicazione	17,50%
Tempo libero e istruzione	6,40%
Altre spese	13,30%
TOTALE	**100,00%**

Fonte: Nostra elaborazione su dati Istat 2013-2017

Anche in questo caso, considerando i settori di cui alle Tab. 13 e 14, attraverso l'utilizzo di apposite matrici I-O, si rileva il valore dell'impatto indotto generato dai consumi delle famiglie i cui compensi sono direttamente erogati dai LNS.

Tab. 13: *Effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori (anni 2013-2019; Valori in Euro)*

	Impatto 2013 su 2023	Impatto 2014 su 2023	Impatto 2015 su 2023	Impatto 2016 su 2023	Impatto 2017 su 2023	Impatto 2018 su 2023	Impatto 2019 su 2023
Alimentari e bevande	286.652,10	287.683,55	287.152,97	287.712,10	288.774,58	296.747,80	304.911,22
Abbigliamento e calzature	89.130,30	89.451,01	89.286,03	89.459,89	89.790,25	92.269,41	94.807,70
Abitazione ed energia	417.794,40	419.297,74	418.524,42	419.339,35	420.887,91	432.508,85	444.407,01
Arredamenti ecc.	75.865,44	76.138,42	75.998,00	76.145,98	76.427,18	78.537,37	80.697,91
Sanità	60.866,83	61.085,85	60.973,18	61.091,91	61.317,51	63.010,52	64.671,09
Trasporti e comunicazione	331.621,42	332.814,68	332.200,86	332.847,71	334.076,87	343.300,91	352.333,87
Tempo libero e istruzione	137.675,34	138.170,74	137.915,90	138.184,45	138.694,74	142.524,18	146.444,97
Altre spese	262.607,06	263.551,99	263.065,92	263.578,15	264.551,50	271.855,91	279.334,57
TOTALE	**1.662.212,89**	**1.668.193,98**	**1.665.117,29**	**1.668.359,53**	**1.674.520,55**	**1.720.754,94**	**1.767.608,33**

Fonte: Nostra elaborazione attraverso matrici I-O ISTAT

Tab. 14: *Effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori (stima anni 2019-Impatto; Valori in Euro)*

	Impatto 2020 su 2023	Impatto 2021 su 2023	Impatto 2022 su 2023	IMPATTO 2023
Alimentari e bevande	309.349,44	305.294,45	310.137,83	**2.964.416,03**
Abbigliamento e calzature	96.051,85	94.649,33	95.595,11	**920.490,88**
Abitazione ed energia	450.115,36	444.801,23	450.161,90	**4.317.838,15**
Arredamenti ecc.	81.753,35	80.434,86	81.339,69	**783.338,20**
Sanità	65.612,43	64.764,78	65.730,62	**629.124,72**
Trasporti e comunicazione	357.462,36	352.417,73	357.223,81	**3.426.300,23**
Tempo libero e istruzione	148.576,59	146.822,47	149.348,78	**1.424.358,16**
Altre spese	283.083,49	279.428,10	283.598,81	**2.714.655,50**
TOTALE	**1.792.004,86**	**1.768.612,95**	**1.793.136,57**	**17.180.521,88**

Fonte: Nostra elaborazione attraverso matrici I-O ISTAT

5. L'impatto sociale dei Laboratori Nazionali del Sud

Con riferimento all'impatto sociale, di seguito e singole rilevazioni.

δ_1 Impatto sociale - Nuove imprese generate

I LNS stimolano la nascita di nuove attività imprenditoriali ad alto contenuto tecnologico.

Nel 2013 i LNS hanno al loro attivo la costituzione di due spin-off. Si tratta di due srl, una nata nel 2006 ed un'altra nel 2011.

Con l'entrata in attività di tali imprese si produce una domanda incrementale di lavoro (oltre naturalmente al lavoro dei titolari delle imprese medesime) e una domanda di fattori produttivi al resto del sistema economico in modo diretto e indiretto. Inoltre i redditi dei nuovi lavoratori (salari e remunerazioni dei titolari d'impresa e dei collaboratori a vario titolo) attivano una maggiore domanda di beni di consumo (effetto indotto).

Si stima il numero di spin-off che possono essere create dal 2018 al 2023 ed i relativi profitti (Tab. 15). Il numero di imprese spin-off negli anni che vanno dal 2020 al 2023 è stato stimato considerando la realizzazione entro il 2020 di un incubatore di imprese promosso dai LNS in collaborazione con il Dipartimento Economia e Imprese dell'Università di Catania. L'incubatore specializzato avrò lo scopo di sostenere la creazione start-up ad alta tecnologia. Si prevede di supportare entro il 2023 la nascita di almeno un altro spin-off.

Basandoci su statistiche in contesti simili, si ipotizza un tasso medio di sopravvivenza dell'80% dopo 15 anni. Il profitto medio delle imprese, sulla base dei bilanci presentati dalle due spin-off già realizzate e su statistiche in contesti simili, si stima in Euro 0 per i primi 2 anni e in Euro 50 mila dal terzo anno con un incremento del 5% annuo nei successivi. In un modello deterministico, il beneficio sociale è dato dalla somma dei profitti ottenuti da tutte le imprese create grazie all'infrastruttura (Tab. 16).

Tab. 15: N. cumulato imprese spin-off generate dal 2013- 2023

Anno	Numero cumulato di spin-off collegate al progetto
2013	2
2014	2
2015	2
2016	2
2017	2
2018	2
2019	3
2020	3
2021	3
2022	3
2023	3

Fonte: Nostra elaborazione su dati LNS

Tab. 16: Impatto 2023 LNS per spin-off generate

INDICATORE	**VALORE**
a. Numero cumulato di spin-off annuo [a]	Come da Tab. 8
b. Profitto annuo [b]	€ 0 per i primi 2 anni € 50.000,00 dal terzo anno con un incremento del 5% annuo nei successivi
IMPATTO SOCIALE 2023 - NUOVE IMPRESE GENERATE DALL'INFRASTRUTTURA Σ^{16} $[a_i*b_i]$, dove i= anno di riferimento da 2013 a 2023	**€ 2.131.225,47**

Fonte: Nostra elaborazione su dati LNS

δ_2 Impatto sociale - Valore dei brevetti

I LNS generano, attraverso i ricercatori e gli scienziati che la utilizzano, conoscenza e innovazione che può essere tutelata tramite brevetto.

Un brevetto registrato produce un rendimento privato per l'inventore e la potenziale propagazione della conoscenza alla società.

In questa sezione si valuta proprio il valore degli *spillover* di conoscenza alla società. Vengono considerati i brevetti prodotti da personale dei LNS nonché da collaboratori, visiting scholar, imprese spin-off che fanno uso della tecnologia e dei dati dell'infrastruttura di ricerca.

Per misurare gli *spillover* di conoscenza derivanti dai brevetti si fa qui riferimento alle citazioni brevettuali.

Le citazioni si trovano allegate al documento brevettuale e sono referenze di brevetti precedenti o di letteratura scientifica. L'insieme delle citazioni viene in genere definita come *prior art* del brevetto. La *prior art* è di solito inserita nel *search report* allegato dagli esaminatori alle domande di brevetto. Le citazioni aiutano sia l'esaminatore che il richiedente a giudicare il grado di novità e il passo inventivo di ogni applicazione di brevetto. I brevetti citati pertanto rappresentano la conoscenza precedente su cui il brevetto che cita costruisce la conoscenza esistente (Jaffe *et al.*, 1993). Ciò rende le citazioni possibili misure degli spillover di conoscenza generata da invenzioni precedenti all'invenzione corrente (Nicotra *et al.*, 2014).

Le citazioni di un brevetto da parte di molti brevetti successivi indicano che il brevetto ha generato importanti ricadute tecnologiche perché numerosi sviluppi si basano sulla conoscenza in esso contenuta. Così, le citazioni di brevetto sono diventare una proxy ampiamente utilizzata per la stima del valore sociale di tecnologie brevettate (si veda, ad esempio, Trajtenberg *et al.*, 1997; Caballero e Jaffe, 1993; Romano *et al.*, 2014).

Il valore sociale dei brevetti dei LNS può così essere stimano moltiplicando il numero di brevetti pubblicati dal 2013 al 2023 per il "valore esterno" di queste.

Si rileva innanzitutto che dal 2013 fino ad oggi sono stati pubblicati 2 brevetti dai LNS e si stima che entro il 2023, grazie al progetto POTLAB e agli altri progetti attivati sia possibile la pubblicazione di ulteriori 2 brevetti.

Per quanto riguarda il valore esterno, questo viene calcolando moltiplicando:

- la mediana di citazioni che il brevetto riceve da terzi nell'intero arco della sua esistenza;
- il valore privato del brevetto;
- la mediana di citazioni che il brevetto effettua.

Avviando una ricerca sul database http://ep.espacenet.com si individuano i brevetti pubblicati da INFN[1]. Da questo elenco si ricava il numero di citazioni medie ricevute e il numero di citazioni medie effettuate. Si tratta rispettivamente di 2 e 7. e modulo

Relativamente al valore privato del brevetto, da uno studio[2] della fondazione CERM per la Commissione Europea, Direzione Generale per il Mercato Interno si stima che il valore medio dei brevetti è di 250-300K.

Da qui si ricava, in un modello deterministico, una stima del valore sociale dei brevetti nel 2023 (Tab. 17).

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[1] In dettaglio la sezione "wordwide" riporta i seguenti brevetti di INFN: 1. Thermal-neutron detectors not making use of he-3, and method for their manufacturing; 2. Intraoperative detection of tumor residues using beta- radiation and corresponding probes; 3. Method for the interactive parallel processing of data on a cluster with the graphic input/output on a visualisation device; 4. Detector based on scintillating optical fibers for charged particles tracking with application in the realization of a residual range detector employing a read-out channels reduction and compression method; 5. Sonda eco-scintigrafica per applicazioni mediche e relativa procedura di fusione delle immagini; 6. Procedimento di realizzazione di fibre cristalline; 7. Dosimetry device for verification of a radiation therapy apparatus; 8. Schermature composite avanzate per neutroni e procedimento per la sua realizzazione; 9. X- and alpha-radiation source, pixe-xrf analysis device using said source and source-production method; 10. Process for production of jewels; 11. Device and method for quality assurance and online verification of radiation therapy; 12. Method for designing a radio-frequency cavity, in particular to be used in a cyclotron, radio-frequency cavity realised using such a method, and cyclotron using such a cavity.

[2] TECHNICAL REPORT "Study on evaluating the knowledge economy what are patents actually worth? The value of patents for today's economy and society", Tender n° MARKT/2004/09/E, Lot, 23 Luglio 2006. In collaborazione con Università Bocconi, Scuola Superiore S. Anna, ZEW and Inno-tec, Ludwig-Maximilians-Universität, Universitat Pompeu Fabra, Eindhoven University of Technology, SPRU-University of Sussex, Université Lyon2, INSEAD, University of Pécs.

Tab.10: Impatto 2023 LNS per pubblicazione brevetti

INDICATORE		**VALORE**
a. Totale brevetti effettivi e stimati (2013 - 2023)		4
b. Valore esterno dei brevetti	b1. Mediana delle citazioni ricevute	2
	b2. Media del valore privato dei brevetti	€ 270.000,00
[b1*(b2/b3)]	b3. Mediana delle citazioni effettuate	7
IMPATTO SOCIALE 2023 - BREVETTI [a*b]		€ 308.571,00

Fonte: Nostra elaborazione su dati LNS

δ_3 Impatto sociale - Valore delle pubblicazioni scientifiche

Per scienziati e ricercatori uno dei principali vantaggi di lavorare presso i LNS deriva dalla possibilità di accedere ed elaborare nuovi dati sperimentali per contribuire alla creazione di nuova conoscenza e, in ultima analisi, per la produzione di risultati scientifici che possono assumere la forma di report tecnici, documenti di lavoro, articoli in riviste scientifiche e monografie.

Quando scienziati e ricercatori trascorrono tempo su un progetto che porta alla realizzazione di output scientifici, si ha un costo opportunità derivante dal non lavorare su un progetto alternativo. Se tale costo opportunità è assunto uguale alla retribuzione oraria media dello scienziato, una proxy ragionevole del valore della produzione scientifica è il suo costo scientifico marginale. Quest'ultimo rappresenta il tempo impiegato dagli scienziati per condurre risultati della ricerca e produrre output scientifici.

Pertanto, il beneficio sociale relativo alla produzione di pubblicazioni scientifiche può essere valutato con il loro costo di produzione marginale (Florio *et al.*, 2015).

Chiaramente, non tutto l'output scientifico ha lo stesso valore per la comunità di riferimento. È necessario "pesare" l'influenza di un articolo moltiplicando il suo costo di produzione marginale per un indicatore di impatto che coglie il valore sociale attribuito al grado di influenza di quel "pezzo" di conoscenza sulla comunità scientifica.

L'indicatore di impatto cattura il valore aggiunto attribuibile alla pubblicazione, ricavato, anche in questo caso, dalle citazioni che l'articolo riceve (Florio *et al.* 2015).

In media negli anni 2013-2017 sono stati pubblicati annualmente circa 30 articoli da ricercatori o collaboratori che operano presso i LNS. Si stima che il numero di articoli pubblicati annualmente dal 2018 al 2023 salga in seguito all'ulteriore potenziamento dell'infrastruttura grazie al progetto POTLAB e ad ulteriori progetti. Da qui il numero medio di articoli annui pubblicati dal 2018 al 2023 sale a 40, e il numero totale a 390.

Il tempo medio che un ricercatore dedica alla ricerca è in genere il 60% della sua attività.

Il resto è per lo svolgimento di adempimenti amministrativi e burocratici, nonché per altra attività di ricerca.

Secondo uno studio della Commissione Europea[3] la produttività media annua di un ricercatore europeo (vari livelli, settori e Nazioni) è di 3 articoli e il suo stipendio lordo medio annuale è di € 40.000.

Il costo marginale di un articolo prodotto da scienziati e ricercatori è dato dal salario medio lordo annuo moltiplicato per la percentuale di tempo riservato alle attività di ricerca e diviso per la produttività media annua degli scienziati.

- Salario medio lordo annuo = € 40.000
- Tempo riservato alle attività di ricerca = 60%
- Produttività media degli scienziati=3
- Inoltre secondo analisi bibliometriche (nello specifico si è fatto riferimento a google scholar) e l'opinione di esperti sul campo, si ha che:
- il numero medio di citazioni di un articolo relativo ai progetti sviluppati presso i LNS è di 7;

[3] Commissione Europea- Direzione Generale Ricerca - Human Resources Mobility and Marie Curie Actions, 2007, "Remuneration of the researchers in the public and private sectors".

- il numero medio di referenze bibliografiche nel campo scientifico di riferimento dei LNS è di 40 per articolo;
- il tempo necessario per valutare l'articolo e decidere di citarlo è di 1 ora.

Pertanto si ha quanto segue nella tabella sotto riportata (Tab. 18).

Tab. 18: Impatto 2023 LNS per pubblicazioni scientifiche

INDICATORE		VALORE
a. Costo marginale di un articolo	a1. Salario medio annuo ricercatore	€ 40.000
	a2. Tempo dedicato alle attività di ricerca	60%
[(a1*a2)/a3]	a3. Produttività media degli scienziati (in numero di articoli)	3
b. Numero pubblicazioni 2013-2023 LNS		390
c. Moltiplicatore di impatto	c1. Numero medio di citazioni ricevute	7
	c2. Numero medio di citazioni effettuate	40
[c1*(c3/c2)]	c3. Tempo valutazione articolo	1h
IMPATTO SOCIALE 2023 - PUBBLICAZIONI SCIENTIFICHE [a*b* (1+c)]		€ 3.680.000,00

Fonte: Nostra elaborazione su dati LNS

δ_4 Impatto sociale - Formazione di capitale umano

I LNS impiegano diverse categorie di personale: ricercatori, personale tecnico (tecnici e ingegneri), personale amministrativo e di supporto, studenti per dottorato di ricerca, ricercatori postdoc, giovani accademici e gli altri utenti a breve termine.

Per studenti, post-doc e giovani visiting researcher, il principale beneficio atteso è un "premio" sul loro stipendio futuro che si ha a seguito dell'acquisizione di nuove capacità e competenze. Si tratta di uno stipendio incrementale guadagnato per tutta la vita dagli studenti e i giovani scienziati che hanno lavorato presso i LNS in confronto ai loro pari.

Concettualmente, due diversi effetti contribuiscono alla formazione del "premio". Da un lato, questo riflette l'incremento salariale marginale maturato da un ex studente che ha trascorso del tempo presso i LNS rispetto allo stipendio che sarebbe stato guadagnato in ogni caso, vale a dire senza tale esperienza. D'altra parte, l'aumento è il risultato del fatto che le persone che hanno trascorso un periodo di formazione presso i LNS hanno maggiori probabilità di essere assunti nei mercati del lavoro che offrono salari medi maggiori.

L'impatto atteso può essere definito come la somma del "premio" ottenuto dagli studenti e dai giovani ricercatori che collaborano con l'infrastruttura.

Dal 2013 al 2023, i LNS hanno svolto e continueranno a svolgere attività di formazione e di accompagnamento di studenti e postdoc, nazionali che internazionali. Finora, dai dati di INFN-LNS risulta che il numero di questi ammonta a circa 150 soggetti nel periodo considerato. Numero che si stima possa giungere a 250 nel 2023. Semplificando si suddividono i 250 studenti nei 10 anni che il periodo da noi considerato, per una media di 25 studenti l'anno.

Studenti e postdoc collaborano con la struttura in media 2 anni e si suppone che entrino immediatamente nel mondo del lavoro l'anno successivo alla conclusione del percorso presso i LNS.

Come precedentemente riportato, secondo uno studio della Commissione Europea[4], lo stipendio lordo medio annuale di un ricercatore europeo è di € 40.000.

Sulla base di informazioni statistiche un premio del 5% sullo stipendio è atteso per gli studenti che hanno svolto un periodo di studio presso grandi infrastrutture di ricerca rispetto ai loro pari che non hanno svolto la stessa esperienza (Florio *et al.*, 2015).

Pertanto si ottiene quanto riportato in Tab. 19.

[4] Si veda nota 3

Tab. 19: Impatto 2023 LNS per incremento capitale umano formato

INDICATORE		VALORE
a. Numero studenti e postdoc LNS che annualmente entrano nel mondo del lavoro a partire dal 2015 (2 anni dopo il loro ingresso ai LNS)		25
b. Premio annuo	b1. Retribuzione lorda media di un ricercatore europeo	€ 40.000,00
[b1*b2]	b2. % Stipendio incrementale	5%
IMPATTO SOCIALE 2023 - CAPITALE UMANO FORMATO Σ^9 [a*b*i] dove i= anno di riferimento dal 2015 al 2023		**€ 450.000,00**

Fonte: Nostra elaborazione su dati LNS

δ_5 Impatto sociale - Servizi al territorio

I LNS forniscono servizi di cui il territorio gratuitamente gode.

- LNS mette a disposizione della regione Sicilia, 120 km di fibra ottica collegando Capo Passero a Catania. La fibra ottica di LNS è attualmente utilizzata dalle Capitanerie di Porto della Sicilia orientale per comunicazioni relative alla gestione immigrati nell'area di competenza. Sono in fase di realizzazione inoltre dei protocolli di intesa con l'Assessorato alla Salute e l'Assessorato alle Attività Produttive della Regione Siciliana per l'utilizzo della fibra ottica. Le ripercussioni socio-economiche di quest'ultima su un territorio sono di grande entità e coinvolgono potenzialmente diversi settori socio-economici. Gli investimenti in infrastrutture di telecomunicazioni creano effetti sull'economia difficili da misurare anche perché, a differenza di altri investimenti infrastrutturali, creano forti esternalità di rete.

Uno studio AGICOM [5] ha analizzato l'impatto complessivo di un investimento per la realizzazione di una NGN (Next Generation Networking) in fibra ottica sullo sviluppo economico italiano. Sono state individuate tre alternative di investimento per l'Italia in generale: l'opzione "minima" (FTTB GPON per il 20% della popolazione investendo 3 mld €) e quella "massima" (FTTH P2P per il 50% della popolazione investendo 13,3 mld €) e la Rete Mista P2P/GPON, per coprire la quasi totalità della popolazione italiana investendo 15,5 mld €. Per ogni categoria di investimento è stato rilevato, secondo la nomenclatura del presente studio, l'impatto economico diretto, indiretto e indotto dell'investimento; e l'impatto sociale. L'impatto totale sull'economia a 10 anni dall'investimento è stato così quantificato come riportato nella tabella sotto (Tab. 20).

Tab. 20: Impatto economico e sociale a 10 anni di investimenti fibra ottica in Italia

Opzioni di investimento	Investimento totale e copertura raggiunta		Effetti economici mld €	Effetti sociali		Effetti totali	
	mld €	Copertura %		Min mld €	Max mld €	Min mld €	Max mld €
Opzione 1	15,5	91%	20,25	89,6	765,5	109,9	785,7
Opzione 2	13,3	50%	17,38	49,2	420,6	66,6	438,0
Opzione 3	3,0	20%	3,92	19,7	168,2	23,6	172,2

Fonte: nostra elaborazione su AGICOM, 2009

Gli effetti economici sono per natura quelli più certi. Quelli sociali invece variano da un minimo ad un massimo in quanto il loro impatto è legato alla capacità del territorio di riuscire a capitalizzare quello che la realizzazione di una NGN può dare al sistema economico per promuovere l'innovazione, il miglioramento dei processi di business, la crescita della produttività e lo sviluppo di un'economia.

L'impatto effettivo dipende da una serie di variabili di carattere sociale e organizzativo, indipendenti dal contenuto d'innovazione inglobato nella soluzione tecnologica e a volte poco correlati con gli elementi di costo del servizio o del prodotto. Vi sono altri fattori che,

[5] Realizzato da centro di ricerca EntER e Università Bocconi, 2009, "L'impatto degli investimenti in NGN sullo sviluppo economico del Paese".

congiuntamente al prezzo, amplificano o deprimono l'impatto di mercato di queste tecnologie: la rilevanza della facilità d'uso; il contesto istituzionale e organizzativo; la presenza di norme che definiscono l'uso di un sistema; l'uso deliberato ed emergente di una tecnologia; il ruolo dei media nei processi di adozione a livello nazionale; l'utilità percepita dall'utente finale; la rilevanza per la produzione di un risultato connesso ad obblighi lavorativi dell'utente; le performance attese nell'uso della tecnologia (AGICOM, 2009).

Si procede pertanto al calcolo della media degli effetti sociali delle tre tipologie di investimento, considerato il valore di impatto minimo. Si giunge così alla stima del moltiplicatore sociale medio minimo su 10 anni, di una rete in fibra ottica. Gli effetti economici sono stati già computati nella prima parte del presente studio.

Prendendo come riferimento proprio questo valore, e moltiplicandolo per i costi della rete in fibra ottica realizzata dai LNS (€ 1.800.000,00), in un modello deterministico, si ha quanto segue (Tab. 21).

Tab. 21: Impatto 2023 LNS per servizi al territorio (connessione fibra ottica)

INDICATORE	**VALORE**
a. Costo rete fibra ottica dei LNS	€ 1.800.000,00
b. Moltiplicatore totale medio, su 10 anni (2013-2023)	5,35
IMPATTO SOCIALE 2020 - SERVIZI AL TERRITORIO (FIBRA OTTICA) [a*b]	**€ 9.627.935,97**

Fonte: Nostra elaborazione su dati LNS

δ_6 Impatto sociale - Knowledge spillover nell'ambito della supply chain

I fornitori di tecnologia, coinvolti in prima linea nella progettazione, costruzione e nel funzionamento dei LNS possono godere di ricadute derivanti proprio dal lavorare per un'infrastruttura di ricerca. Le imprese della catena di fornitura dei LNS affrontano la sfida di fornire soluzioni industriali non in commercio per far fronte ad una serie di problemi tecnologici complessi. Tale situazione ha dato e dà alle imprese l'opportunità di collaborare con il personale scientifico e tecnico dei LNS, di ottenere nuove conoscenze e competenze tecnologiche e di acquisire un incentivo ad espandere il proprio status attuale di conoscenze. Il beneficio del *learning-by-doing* dei fornitori può produrre diverse tipologie di sviluppi, che vanno dai miglioramenti apportati alle attrezzature già esistenti alla realizzazione di processi per la produzione di nuovi strumenti che possono trovare applicazione in altri settori della scienza e dell'industria.

Il valore sociale del *learning-by-doing* può essere valutato come il costo evitato alle imprese dall'applicazione della nuova conoscenza ed esperienza ottenuta gratuitamente come spillover di conoscenza. Pertanto si tratterebbe del costo sostenuto dall'azienda per pagare le ore di supporto alla progettazione di un ricercatore esterno.

Presso i LNS 15 ditte fornitrici sono state coinvolte dal 2013 al 2017 nella fornitura di prodotti di alta tecnologia su misura. Si ipotizza che altrettante saranno interessate negli anni successivi per gli investimenti previsti dal progetto POTLNS e da altri progetti. Queste imprese sono potenzialmente beneficiarie di *spillover* tecnologici e di conoscenza perché molti dei loro prodotti sono co-progettati con il cliente. Sulla base delle informazioni fornite dai LNS e del prezzo di mercato di un ricercatore, sono state considerate le seguenti ipotesi:

- in media, la co-progettazione di oggetti ad alta tecnologia impiega 150 ore lavorative di un ricercatore LNS per azienda fornitrice;
- ogni ora lavorativa di un ricercatore esterno ha un costo di € 100 lordi.
- In un modello deterministico, il totale del valore del *learning-by-doing* per i fornitori è di € 450.000,00 (Tab. 22).

Tab. 22: Impatto 2023 LNS per knowledge spillover nella supply chain

INDICATORE	VALORE
a. Numero aziende fornitrici 2013-2023	30
b. N. ore impiegate per la co-progettazione	150
c. Costo di un'ora lavorativa di un ricercatore	€ 100,00
IMPATTO SOCIALE 2023 - KNOWLEDGE SPILLOVER NELLA SUPPLY CHAIN [a*b*c]	**€ 450.000,00**

Fonte: Nostra elaborazione su dati LNS

δ_7 Impatto sociale - Attrattività "scientifica"dell'area

L'area in cui si collocano i LNS gode di un flusso di ricercatori interessati al sito, di scolaresche in visita all'area, di studenti dei corsi formativi attivati, di una attività congressuale che si ripercuote sulle spese di alloggio e ristorazione, trasporti, servizi vari e giornali-editoria.

Ogni anno dal 2013 si rileva presso LNS la presenza di circa 250 studiosi provenienti da tutta Europa per una media di 2,5 giornate[6].

Secondo Osservatorio Congressuale Italiano (2014), la spesa media per persona al giorno di visitatori per motivi di lavoro/congressi in Sicilia è di € 188,00.

Da aggiungere a questa vi è il costo del trasporto per i visitatori che viaggiano meno di 200 km per raggiungere Portopalo (12%) utilizzando l'auto, e per i visitatori che, dovendo ricoprire distanze maggiori, utilizzano l'aereo (88%). Di seguito (Tab. 23), una sintesi delle percentuali dei visitatori per mezzo di trasporto utilizzato e del costo di trasporto (basato sulle tabelle ACI 2016 per il trasporto in auto e sul valore medio del biglietto per il trasporto aereo).

In un modello deterministico, ponendo che il numero di visitatori si mantenga stabile fino al 2023, si avrà l'impatto dell'attrattività scientifica dell'area così come riportato nella tabella sotto (Tab. 24).

Tab. 23: % di visitatori per modalità di trasporto e costo

Distanza	Modalità di trasporto	% di visitatori	Costo del trasporto (A/R)
<200 km	Auto	12%	€ 140,00
>200 km	Aereo	88%	€ 180,00

Fonte: Nostra elaborazione su dati LNS

Tab. 24: Impatto 2023 LNS per incremento attrattività scientifica dell'are

INDICATORE		VALORE
a. Numero medio ospiti annuali 2013-2023		250
b. Numero anni considerati 2013-2023		10
c. Numero medio giorni di permanenza		2,5
d. Spesa media giornaliera per ospite		€ 188,00
e. Spesa trasporto annuale	e1. Spesa media trasporto in auto per visitatore	€ 140,00
	e2. Numero visitatori che utilizzano l'auto	250*12%= 30
[(e1*e2) + (e3*e4)]=43.800	e3. Spesa media trasporto aereo per visitatore	€ 180,00
	e4. Numero visitatori che utilizzano l'aereo	250*88%= 220
IMPATTO SOCIALE 2023 - ATTRATTIVITÀ SCIENTIFICA [(a*b*c*d)+(e*b)]		**€ 1.613.000,00**

Fonte: Nostra elaborazione su dati LNS

δ_8 Impatto sociale - Rafforzamento dell'immagine di INFN

I LNS rafforzano l'immagine del brand INFN, istituto promotore e gestore dell'infrastruttura. Consolidare il brand e di conseguenza incrementare la reputazione, soprattutto nelle organizzazioni basate sulla conoscenza, è una grande risorsa. Sono concetti immateriali che generano identità

[6] Nella presente sezione non si inserisce il valore della liquidità immessa quotidianamente nell'area di riferimento dal personale che opera presso i LNS. Gli effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori sono stati infatti già rilevati e registrati nella sezione γ3.

condivisa attraverso cui raccontare l'autenticità delle attività e dei risultati conseguiti.

Il termine brand sta per incendio e può essere tradotto come marchio di valore, segno impresso su qualcosa, ma anche processo dinamico (branding), percorso creato per "distinguere" e "riconoscere".

Con il processo di costruzione dell'immagine di INFN si innesta un solido patto comunicativo tra istituto e stakeholders e si incrementa simbolicamente ed economicamente il suo valore.

Il brand svolge la funzione di rintracciabilità dell'Istituto e di facilitazione all'incremento delle performance di produzione, innovazione, commercializzazione e consenso nel contesto di riferimento.

I risultati del rafforzamento del valore del brand di INFN a seguito del potenziamento dei LNS sono concreti in termini di benefici, anche di matrice economica, per l'Istituto e per la sua sostenibilità: il tasso di fidelizzazione e soddisfazione nel sistema di valore in cui INFN opera aumenta; le istituzioni locali, nazionali ed europee risultano più inclini a dare fiducia e riconoscere il valore della capacità di ricerca; il sistema finanziario, anche a livello internazionale (e.g. BEI e FEI), mostra maggiore sensibilità nei suoi meccanismi di rating verso reputazione dell'Istituto.

Il rafforzamento dell'immagine di INFN comporta l'ampliamento del suo network di ricerca ed istituzionale con possibilità di incrementare numero e rilevanza di riconoscimenti, commesse e finanziamenti in progetti locali, nazionali e internazionali.

L'attività dei LNS, nel periodo 2013-2017, ha aumentato di circa il 10% il valore complessivo di risorse acquisite rispetto al passato. In particolare, l'acquisizione delle seguenti fonti di finanziamento è direttamente riconducibile al ruolo svolto dalla diffusione dell'immagine positiva dei LNS: ESFRI - European Strategy Forum on Research Infrastructures, Fondo Ordinario per il finanziamento degli Enti e istituzioni di ricerca (FOE), CIPE, PON, POR.

Il valore stimato dei fondi aggiuntivi attratti quale conseguenza dell'affermazione e dell'incremento del valore del brand, per gli anni 2017-2023, è anche in questo caso reinvestito per l'attività di potenziamento dei laboratori. L'impatto economico di tale valore è pertanto incluso all'interno della sezione "β1 Impatto indiretto - Liquidità reimmessa, a livello locale, nazionale e internazionale, in cambio di controprestazioni per investimento".

δ_9 Impatto sociale - Valore dell'esistenza

Per i LNS, un ulteriore impatto sul benessere sociale può essere correlato al suo potenziale di scoperta. Anche se il valore delle pubblicazioni derivanti da tali scoperte riflette, in termini statistici, il beneficio sociale per gli scienziati di avanzare la conoscenza all'interno della loro comunità, la scoperta ha in sé un valore sociale intrinseco e può portare un certo numero di nuovi miglioramenti del benessere umano che non sono stati contabilizzati finora. I benefici aggiuntivi vengono definiti come i "benefici del non uso". Questo approccio e la terminologia è presa in prestito dall'economia ambientale, per cui a qualsiasi risorsa o bene naturale può essere assegnato un valore economico totale che, a sua volta, può essere scomposto.

- Il valore d'uso si riferisce ai benefici diretti o indiretti derivanti dall'uso effettivo di un'attività o dall'uso potenziale o opzionale, che indica il valore attribuito al futuro, sulla base di opportunità note.
- Il valore del non uso denota il valore sociale del preservare semplicemente una risorsa naturale rispetto al non preservarla. Il valore del non uso include un valore lascito che nasce dal desiderio di conservare certe risorse a beneficio delle generazioni future e di un valore di esistenza, relativa semplicemente al sapere che quella risorsa esiste anche se non ha alcun effettivo o previsto utilizzo per chiunque ed è indipendente da qualsiasi motivazione altruistica. Inoltre, possono anche esistere situazioni nelle quali l'uso pratico di un bene può essere previsto in principio ma è ancora sconosciuto. In questi casi, il suo valore è determinato da quello che viene generalmente chiamato valore quasi-option.

Per individuare la disponibilità a pagare da parte dei contribuenti per potenziali scoperte, è stata realizzata un'indagine valutazione contingente (si veda Florio *et al.* 2015). In particolare, l'indagine è stata effettuata in formato referendum NOAA-panel su un campione casuale di 600 contribuenti di paese LAMBDA (contando una popolazione di 5 milioni di contribuenti).

Il campione è stato individuato utilizzando un semplice metodo di selezione in modo da essere rappresentativo della popolazione. Grazie all'interazione faccia a faccia, l'indagine ha mostrato un tasso di risposta molto elevata di 80%.

Gli intervistatori hanno rilevato la misura della volontà a contribuire degli intervistati nel sostegno di un istituto di ricerca, simile per molti versi ai LNS. I risultati dell'indagine hanno la distribuzione riportata in tabella 25.

Tab. 25: Disponibilità a pagare dei contribuenti per il supporto di una infrastruttura di ricerca

Classe (€ per anno) disponibilità a pagare	Media di € per anno disponibilità a pagare	Frequenza relativa
0	0	10%
0,1-0,5	0,3	10%
0,6-1,0	0,8	45%
1,1-1,5	1,3	20%
1,6-2,0	1,8	15%

Fonte: Nostra elaborazione su dati LNS

Quindi, considerando un orizzonte temporale di 10 anni, il valore di esistenza al 2023 per le scoperte dei LNS solamente per i contribuenti siciliani è visibile nella tabella 26. Il dato aumenterebbe a dismisura se si valutasse il valore dell'infrastruttura non solo a livello regionale ma anche nazionale, a livello europeo e mondiale, vista la rilevanza di questa per la scienza.

Tab. 26: Impatto 2023 LNS per valore sociale della sua esistenza

INDICATORE	**VALORE**
a. Disponibilità a pagare media annua	0-0,3-0,8-1,3-1,8
b. Anni considerati 2013-2023	10
c. Frequenze relative	10%-10%-45%-20%-15%
d. Contribuenti media siciliani (2005-2016)	2.500.000
IMPATTO SOCIALE 2023 - ESISTENZA [(a*b)*(c*d)]	**€36.800.000,00**

Fonte: Nostra elaborazione

6. Risultati e conclusioni

Dopo aver misurato e descritto tutti i livelli d'impatto economico dei LNS sul territorio siciliano nel corso del 2013-2023, è possibile calcolare il valore complessivo della presenza dei LNS al 2023 (Tab. 27).

Tab. 27: Impatto generale 2023 LNS

α1 Salari e gli stipendi erogati	€ 27.847.269,82
α2 Tasse versate	-
α3 Profitti reinvestiti.	-
α TOTALE IMPATTO DIRETTO 2020	€ 27.847.269,82
β1 Liquidità reimmessa, a livello locale, nazionale e internazionale, in cambio di controprestazioni per investimento	€ 61.230.740,90
β2 Liquidità reimmessa in cambio di controprestazioni per gestione	€ 202.213.444,97
β TOTALE IMPATTO DIRETTO 2020	€ 263.444.185,86
γ1 Effetti indotti dagli investimenti	€ 50.614.543,66
γ2 Effetti indotti dai costi di gestione	€ 114.416.572,82
γ3 Effetti indotti dai consumi di beni durevoli e non durevoli, al netto della quota di risparmio, dei dipendenti e collaboratori	€ 17.180.521,88
γ TOTALE IMPATTO INDOTTO 2020	€ 182.211.638,36
δ1 Nuove imprese generate dall'infrastruttura	€ 2.131.225,47
δ2 Valore dei brevetti	€ 308.571,00
δ3 Valore delle pubblicazioni scientifiche	€ 3.680.000,00
δ4 Formazione di capitale umano	€ 450.000,00
δ5 Servizi al territorio	€ 9.627.935,00
δ6 Knowledge spillover nella supply chain	€ 450.000,00
δ7 Attrattività "scientifica"dell'area	€ 1.613.000,00
δ9 Rafforzamento dell'immagine di INFN	valorizzato in β1
δ TOTALE IMPATTO SOCIALE 2020	€ 18.260.731,47
IMPATTO TOTALE 2020 (α + β + γ + δ)	€ 491.763.825,51

Fonte: Nostra elaborazione

Sommando il valore di tutti gli impatti generati, si ottiene un valore di € 491.763.825,51. Ciò significa che i costi di investimento e gestione dei LNS nel periodo 2013-2023 si trasformano in ricchezza per il territorio regionale (circa il 70% in più del valore immesso).

L'equazione di base del modello è la seguente:

$Y = \alpha + \beta + \gamma + \delta$

dove:

Y = IMPATTO GENERALE LNS

α = impatto economico diretto

β = impatto economico indotto

γ = impatto sociale

Si è ritenuto opportuno non inserire nel calcolo dell'impatto generale 2020 il "valore dell'esistenza", come analizzato nella sezione "δ11 Impatto sociale - Valore dell'esistenza". Ciò non perché non rientri a pieno titolo nell'analisi dell'impatto generale 2020 ma perché l'elevato valore (€36.800.000,00) solo con riferimento alla Sicilia) potrebbe ridurre la percezione dell'impatto del resto delle variabili considerate.

Il contributo, pertanto, proseguendo l'analisi svolta in Nicotra *et al.* 2017, delinea una metodologia di rilevazione e valutazione dell'impatto socio-economico di una infrastruttura di ricerca. Lo studio considera l'impatto economico diretto, cioè correlato ai trasferimenti in denaro sotto forma di compensi erogati, tasse e profitti reinvestiti; l'impatto economico indiretto, generato nel sistema economico attraverso la catena produttiva formata dai fornitori di beni e servizi di attività direttamente riconducibili al settore analizzato; l'impatto economico indotto, generato attraverso le spese ed i consumi indotti dall'impatto diretto ed indiretto. Questo è costituito dall'aumento della spesa che si registra nell'area geografica di riferimento dove aumenta l'attività economica di fornitori di beni e servizi la cui attività non è direttamente riconducibile al settore analizzato; l'impatto sociale, derivante, tra l'altro, dal valore dei brevetti generati, degli spin-off creati, delle pubblicazioni scientifiche, del capitale umano formato, dal knowledge spillover.

Applicando la metodologia ai Laboratori Nazionali del Sud, parte dell'Istituto Nazionale di Fisica Nucleare, la somma delle singole valorizzazioni ha fornito la stima totale dell'impatto generato dall'infrastruttura. Si tratta della misurazione della nuova ricchezza incrementale generata dalla realizzazione dell'infrastruttura sul territorio.

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Management studies

Determinants of business model innovation: the role of proximity and technology adoption

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Abstract

Objectives. *This paper investigates the non-technological and technological determinants of BMI, focusing on the role of proximity dimensions and technology adoption (TA). In particular, the paper looks at whether technological (TP), organizational (OP) and social proximities (SP) influence TA and BMI, while geographical proximity (GP) moderates these relationships. Then, a mediation effect of TA over TP, OP, and SP on BMI is also tested.*

Methodology. *Based on a unique sample of 123 firms, the impact of the technological, organizational and social proximities over TA is tested by an OLS regression analysis. Then, a logit regression is adopted to test the impact of independent variables on BMI. Finally, a mediation analysis - obtained through g-computation formula - is adopted to look at the mediation effect of TP.*

Findings. *For both TA and BMI, TP has a positive influence and GP acts as moderator of SP. Moreover, while GP negatively influences TA, it has an inverted U-shaped impact on BMI. Lastly, TA has a positive influence on BMI, and it is able to mediate the effect of TP over BMI.*

Research limits. *The study does not consider the multi-dimensional nature of each proximity dimension.*

Practical implications. *This study suggests that firms should invest in TA if they want to innovate their business model, but also be careful at collaborating with too much socially proximate partners that may hinder BMI. However, when these partners are geographically close, their negative influence is mitigated.*

Originality of the study. *This is the first quantitative study on the role of proximity dimensions on BMI.*

Key words: *business model innovation; geographical proximity; organizational proximity; technological proximity; social proximity; technology adoption*

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1. Introduction

In a complex scenario made of heterogeneous actors, where firms boundaries are blurred and innovation lies in networks (Doganova and Eyquem-Renault, 2009; Chesbrough and Schwartz, 2007), it is crucial to understand if and how firms should develop and innovate their approach to making business. To tackle this issue, several academics from management areas such as entrepreneurship (Zott and Amit, 2007; Doganova and Eyquem-Renault, 2009; Berbegal-Mirabent, 2012), innovation (Teece, 2010; Chesbrough, 2010; Casprini *et al.*, 2018), and strategy (Baden-Fuller and Mangematin, 2013; Magretta, 2002) employed *business model* (BM) as unit of analysis.

Unfortunately, no agreement can be found among scholars on BM definition (Zott *et al.*, 2011). So, while several researchers defined the BM as "*the content, structure, and governance of transactions*" (Amit and Zott, 2001, p. 511) or as "*the combination of a firm's business strategy, organization, and capabilities and the resulting financial structure*" (Casprini *et al.*, 2014, p. 176), others as "*the heuristic logics that connects technical potential with the realization of economic value*" (Chesbrough and Rosenbloom, 2002, p. 529). Nevertheless, the following BM features are undeniable: "*the model must link the workings inside the firm to outside elements*" (Baden-Fuller and Mangematin, 2013, p. 413) and it is influenced by the context where the firm operates (Casprini *et al.*, 2014; Pucci, 2016). Therefore, whatever a BM is named (architecture, conceptual tool, description, etc.) or defined, it should explain "*how an organization is linked to external stakeholders, and how it engages in economic exchanges with them to create value for all exchange partners*" (Zott and Amit, 2007, p. 181). For example, defining a cooperation and partnership strategy, the BM may enable firms to gather new knowledge from outside, and generate a market outcome (Zott *et al.*, 2011).

The literature on BM has underlined its ability to enhance or hinder firm's competitive advantage (Markides and Charitou, 2004; Teece, 2010), economic performance (Pucci *et al.*, 2017a; Zott and Amit, 2007), internationalization (Casadesus-Masanell and Ricart 2010; Onetti *et al.*, 2012), and innovation (Chesbrough, 2010; Loon and Chik, 2018). For these reasons and for the daily usefulness, practitioners more than academicians recognized its economic value (Doganova and Eyquem-Renault, 2009). Today, much more discussion has been devoted to business model innovation (BMI), underlining its positive impact on firms' performances (Lambert and Davidson, 2013). Indeed, entrepreneurs constantly looks for new ways of doing business, thus new BMs, in order to overturn the existing competitive rules leading the market (Ireland *et al.*, 2001). Therefore, the literature investigated those factors enabling BMI, highlighting technological and market related forces as possible causes (Lambert and Davidson, 2013; Casprini *et al.*, 2018). However, even though BM is undeniably tied to external factors, the social, spatial, cognitive, and cultural determinants have been largely overlooked (Mason and Chakrabarti, 2017).Our research aims to contribute to the literature answering the following research questions: (1) *How does technology adoption effect business model innovation?; (2) How do socio-cognitive relational structures influence business model innovation?* Indeed, to the best of our knowledge, no paper has investigated quantitatively to what extent technological proximity, organizational proximity and social proximity influence business model innovation and what is the role of geographical proximity in moderating these relationships.

As the BM is a "*cognitive instrument*" defined by the "*understanding of causal links*" (Baden-Fuller and Mangematin, 2013, p. 412), we expect socio-cognitive dimensions to influence the process of BMI, thus swaying how actors cognize new causal links. To test this relationship, we employ the proximity framework (Boschma, 2005; Knoben and Oerlemans, 2006), that has been applied by several management scholars (Lazzeretti and Capone, 2016; Geldes *et al.*, 2017; Mason and Chakrabarti, 2017). Indeed, proximity has been understood as a pre-condition for innovation, nurturing knowledge and technology transfer among actors (Gertler, 1995; Knobben and Oerlemans, 2006; Pucci *et al.*, 2017b): this corroborates its suitability in answering our second research question.

The paper is structured as follow: section two provides a review of the relevant literature and the conceptual model; section three discusses methodology and sample characteristics; section four provides the research findings; section five presents discussion, conclusions and limitations of this research.

2. Literature review and conceptual model

2.1 Business model innovation

Defining BMI presents two levels of complexity. A first level is linked to the fact that literature still debates about *what* a BM is (Zott *et al.*, 2011). If in its broadest terms a BM refers to the ways a company creates, delivers and captures value (Teece, 2010), a BMI could be simply defined as innovating a firm's BM. A second level of complexity is linked to its potential *dynamic* nature. Indeed, whether BM *per se* has been treated as a static concept, BMI may refer to either a completely new BM, as in the case of AirBnB (Mikhalkina and Cabantous, 2015), or to the evolution of an existing BM (Casprini *et al.* 2014, Bohnsack *et al.*, 2014). This implies that BM can be considered either as an *outcome* or as a *process* (Foss and Saebi, 2017). Referring to the former, literature has looked at two main aspects: the intensity and the audience of BMI. For what concerns the intensity, we can distinguish between incremental and radical BMI, on the basis of how much a BM is different from an existing one (Foss and Saebi, 2017). For example, Amit and Zott (2012) specify that a BMI could happen in several ways such as the addition of new activities or the change of parties performing one/more of the activities. For what concerns the audience, a BM may be novel for the firm or the industry (Casprini, 2015; Foss and Saebi, 2017). Referring to BMI as a process, literature is very heterogenous and has focused on several aspects such as the exploration and exploitation phases an established company could face in innovating its BM (Sosna *et al.*, 2010), the learning mechanisms in the BMI trajectories (Berends *et al.*, 2016), and the barriers - such as the resistance to modify asset configuration - to be faced in changing a BM (Chesbrough, 2010).

Beyond the definitional aspects, a crucial element is linked to understanding what drives BMI or, in other terms, its determinants. In particular, the drivers of BMI can be summarized in two broad categories: technological vs. non-technological factors. *Technology* represents undoubtedly a key driver of BMI (Gambardella and McGahan, 2010; Johnson *et al.*, 2008), as also evidenced by the fact that BM literature has flourished following the advent of ICTs (see Zott *et al.*, 2011 for a literature review). Additionally, research has also investigated the impact of sustainable technologies - as those applied in the case of electric vehicles (Bohnsack *et al.*, 2014) - as the starting point of BMI for all, established and entrepreneurial businesses. More recently, the diffusion and adoption of industry 4.0 technologies has also posited new challenges for established firms that are trying to integrate 3D printing, could computing and robotics in their activities (Müller *et al.*, 2018). Overall, it is evident that digitalization has enabled firms to innovate the way they create and capture value, both in the case of manufacturing firms (Coreynen *et al.*, 2017) and services (Casprini *et al.*, 2018; Remane *et al.*, 2017). *Non-technological factors* have been less investigated or jointly investigated with technological ones. Among the drivers of BMI we can cite the economic conditions and legislation (Ghezzi *et al.*, 2015; Murray and Scuotto, 2016; Sosna *et al.*, 2010), disruptive changes factors such as changes in customer habits and competitor strategy change (Ghezzi *et al.*, 2015; Murray and Scuotto, 2016), proximity (Mason and Chakrabarti, 2017), and the cognitive antecedents (Osiyevskyy and Dewald, 2015). For example, among the disruptive factors, we can mention sustainability. Many firms are changing their business models in order to be more sustainable not only from an economical, but mainly from a social and environmental point of view (see Bocken *et al.*, 2014 for a recent literature review on sustainable business model). Indeed, as Foss and Saebi (2017)'s literature review evidences, identifying and understanding the determinants of BMI is an important gap to address.

2.2 Proximity dimensions

The relationship among proximity, learning, knowledge creation, and innovation has largely attracted academic attention (Torre and Gilly, 2000; Boschma, 2005; Knoben and Oerlemans, 2006) and several scholars have recently highlighted proximity as a driver able to foster knowledge transfer among actors (Fitjar *et al.*, 2016; Capone and Lazzeretti, 2018; Rodrìguez *et al.*, 2018). A great issue within the proximity literature has always been the conceptualization and definition of such a complex variable, thus leading to many divergences, overlaps and ambiguities (Knoben and Oerlemans, 2006). Nevertheless, the literature agrees on proximity multidimensionality, thus distinguishing at least five dimensions: cognitive, institutional, organizational, social, and geographical (Boschma, 2005; Fitjar *et al.*, 2016; Capone and Lazzeretti, 2018). Recently, a technological facet has also been accepted (Cantù, 2010; Enkel and Heil, 2014; Isaksson *et al.*, 2016).

Geographical Proximity (GP) looks purely at the physical distance among actors (Boschma, 2005), known as a channel able to foster knowledge transfer across face-to-face interactions (Bindroo *et al.*, 2012; Fernandes and Ferreira, 2013). Indeed, the transfer of complex and strategic knowledge, both tacit and explicit, is facilitated by close proximity among actors and organizations (Torre and Gilly, 2000; Knoben and Oerlemans, 2006). Though, GP is neither a necessary nor a sufficient condition for knowledge transfer, but it may act as a catalyst fostering the development and influence of other proximity dimensions (Boschma, 2005; Geldes *et al.*, 2017).

Bounded rationality influences not only the ability to search for new knowledge, but also the way in which actors do structure and perform that search (Simon, 1995; Boschma, 2005). In such a cognitive constraint, at least two dimensions of proximity should be considered: *Cognitive* (CP) and *Technological Proximity* (TP). CP is defined as the affinity or distance in individual perceptions and cognition of phenomena (Knoben and Oerlemans, 2006), that is determined by both absorptive capacity and learning potentials (Boschma, 2005). Conversely, TP looks at the knowledge base that is at actors' disposal to acquire or exchange a specific technology (Zeller, 2004; Knoben and Oerlemans, 2006). So, while CP looks at efficient communication, TP "*refers to the extent to which actors can actually learn from each other*" (Knoben and Oerlemans, 2006, p.78).

Organizational proximity (OP) "*consists of shared organizational principles, rules, and codes, including a corporate identity and a corporate philosophy (Blanc and Sierra 1999, 196), to promote a certain coherence within a firm and compatibility among collaborating firms*" (Zeller, 2004, p. 88). Therefore, OP looks both to the inner-firm logic of belonging/similarity (see also Torre and Rallet, 2005), and to the inter-firms compatibility (see also Boschma, 2005).

Institutional proximity (IP) refers to both formal and informal "*humanly devised constraint*" (North, 1991, p. 97) that are likely to influence socio-economic interactions. Therefore, not only the "*rules of the game*" governing economic actors, but also cultural habits and values (Boschma, 2005). Thus, IP is likely to foster knowledge transfer decreasing transaction complexity through the sharing of common rules and values.

Social proximity (SP) is able to decrease risk of opportunism felt by economic actors resorting to trust mechanism (Hansen, 2015). Indeed, it "*refers to the strength of social ties between agents at the micro-level resulting from friendship, family relations or previous work-related interactions*" (ibid., 2015, p. 1674). This concept is rooted in the Granovetter's embeddedness, thus highlighting the ability of "*concrete personal relations and structures (or "networks") of such relations in generating trust and discouraging malfeasance*" (1985, p.490).

Perhaps counterintuitively, it should be underlined that higher proximity does not simply bring higher innovation. As emphasized by Boschma (2005), both too high and too low proximity may negatively affect innovation: also known as the "*proximity paradox*" (Broekel and Boschma, 2012). Indeed, an insufficient proximity between actors is likely to prevent learning, knowledge transfer, and innovation, while a too high proximity may generate a lock-in effect, thus redundancy of information and knowledge. This intuition has been empirically supported, thus highlighting that

actors at the right distance outperform those in lower or higher proximity positions (Fitjar *et al.*, 2016).

2.3 Conceptual model and hypothesis

As previously highlighted, proximity is able to foster knowledge flow among actors both across formal and informal relationships, thus enhancing the sharing of technical advices, technology adoption and the development of innovation (Lazzeretti and Capone, 2016; Capone and Lazzeretti, 2018). Therefore, proximity dimensions are not only able to influence collaboration *per se*, but also the output of that collaboration (Werker *et al.*, 2019).

Gertler (1995) was among the first authors to investigate the impact of proximity dimensions over technology adoption (TA), thus highlighting that physical, organizational, and cultural "*closeness*" are important factors for the adoption of advanced technologies. More recently, Feldmann *et al.* (2015) analyzed rDNA technologies diffusion, showing the crucial role of social and cognitive proximity in fostering TA. Still, to understand how proximity dimensions may affect TA is an open topic of inquiry, calling for further understanding since "*technology diffusion will vary across industries, regions and time periods and for incremental rather than for radical technological breakthroughs*" (Feldman *et al.*, 2015, p. 814). The importance of studying technology adoption is crucial especially in this moment of transition towards the Fourth Industrial revolution. Several new technologies such as 3D printing, big data, robotics are becoming more diffused and easier adopted thanks to their lower costs, improved performance (Schmidt *et al.*, 2015; Strange and Zucchella 2017), and public investments (e.g. the so-called Piano Calenda in Italy). However, contrary to previous industrial revolutions, Industry 4.0 highlights the importance of technology adoption by the several partners along their supply chain in order to fully realize its potential value. Indeed, it is not the sole adoption of a technology within a firm, but the adoption and integration of multiple technologies across several partners that make the difference between a simple operational improvement and a new business model. In order to contribute to this debate, this study considers GP, TP, OP, and SP as determinants of TA. Indeed, it does not investigate: IP, as differences in formal institutions are not relevant on this research contest and informal institutions are likely to overlap the notion of OP (Knobben and Oerlemans, 2006); CP, since we are investigating specific technologies and their related knowledge. Therefore, looking at formal and informal relationships among supply chain partners, our first hypothesis is:

HP.1: Technological, organizational and social proximity foster technology adoption.

As highlighted by the literature (Kirat and Lung, 1999; Boschma, 2005; Knobben and Oerlemans, 2006), GP is not a sufficient condition to foster knowledge transfer. Indeed, GP "*may enhance interactive learning and innovation more indirectly, most likely by stimulating the other dimensions of proximity*" (Boschma, 2005, p. 71). Geldes *et al.* (2017) tried to empirically test this intuition investigating the ability of GP to moderate the impact of non-spatial proximity over inter-organizational cooperation, obtaining a not significant effect. Also, Guan and Yan (2016) investigated the ability of GP to moderate TP influence over re-combinative innovation. Again, the empirical results did not support the theoretical intuition. Lastly, through a qualitative analysis, Letaifa and Rabeau (2013) found that geographical proximity may decrease the likelihood of social proximity development.

Given the divergent and scarce research on this challenging theoretical/empirical debate, we aim to test the following:

HP.2: Geographical proximity is able to positively moderate the impact of technological, organizational and social proximity on technology adoption.

In addition, as we have seen, TA is one of the main drivers of BMI. Indeed, the introduction of new technologies in a firm's existing BM may change the way the firm creates and captures value. Literature is plenty of examples describing how new technologies have influenced many industrial sectors such as logistic (Alberti-Alhtaybat, *et al.*, 2019) and shared mobility (e.g. Casprini *et al.*, 2018) and empirical evidence is cumulating about the impact of digital (Li, 2018), 3D printing (Rayna and Striukova, 2016) and more in general industry 4.0 technologies (Müller *et al.*, 2018) on BMI. Consequently, our third hypothesis is:

HP.3: Technology adoption fosters business model innovation.

Furthermore, a recent qualitative research (Mason and Chakrabarti, 2017) looks at the role of proximity in the process of business model design. In particular, it proposes an analytical framework combining Boschma's (2005) proximities with the three BM elements of technology, market offering and network architecture, showing "*how managers and entrepreneurs organize their business activities to connect to business networks and markets*" (Mason and Chakrabarti, 2017: p. 78). To the best of our knowledge, no paper has investigated quantitatively to what extent TP, OP and SP influence BMI. Nonetheless, proximity may be considered as a potential non-technological determinant of BMI. Henceforth, our fourth hypothesis is:

HP.4a: *Technological, organizational and social proximity influence business model innovation.*

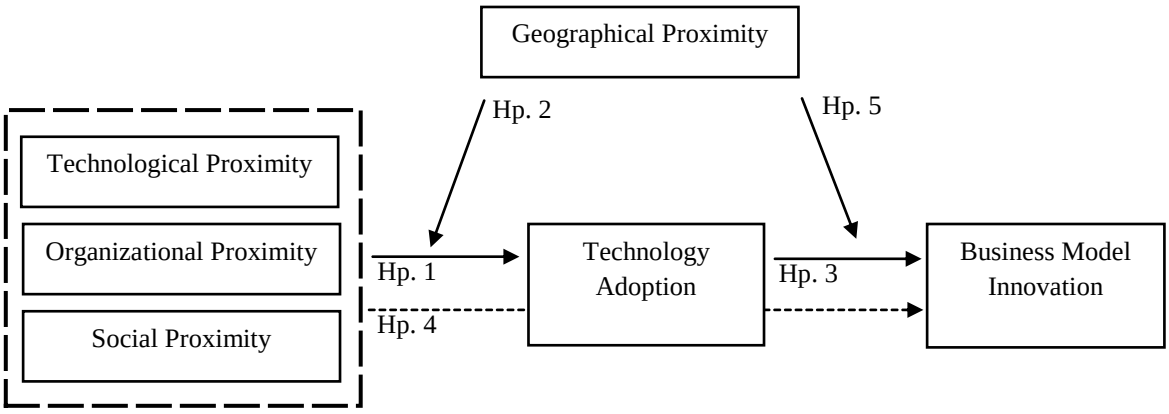
Moreover, since we have hypothesized that TP, OP and SP influences TA, we also suggest that:

HP.4b: *Technology adoption mediates the impact of technological, organizational and social proximity on business model innovation.*

Finally, as previously shown, the debate on the ability of GP to stimulate the other proximity dimensions is still open (Boschma, 2005; Guan and Yan, 2016; Geldes *et al.*, 2017). Therefore, we aim to test the following:

HP.5: Geographical proximity moderates the effect of technological, organizational and social proximity on business model innovation.

Fig. 1: Conceptual Model



Source: our elaboration

3. Methodology

Data were collected through a structured survey submitted to a sample of Italian manufacturing firms during July and November 2018. Particularly, we gathered answers from firms involved mainly in B2B transactions, such as machinery, equipment, and components producers. Indeed, B2B firms offer a relevant case and suitable sample to test the relevance of proximity determinants, receiving both upstream, downstream, and horizontal stimuli from their supply chain partners. Meanwhile, the choice of an Italian sample was led by convenience, but we acknowledge the significance of an international comparison, leaving space for further research.

The collection process has been performed in two steps. Firstly, the questionnaire (introduced by a presentation letter) was sent by email to a sample of 467 Italian manufacturing firms. Secondly, a printed version of the survey was administered to entrepreneurs and managers during several practitioner conferences organized by ADACI (Italian purchasing and supply management association). From the first step we collected 31 survey answers, while from the second one we gathered 107 answers. Further, we deleted observations containing missing values, thus the final sample is composed by 123 complete and usable survey answers. Finally, we employed data from the Chamber of Commerce to collect information regarding firm's age and employees.

On the basis of number of employees, the final sample is composed as follow: 38 micro firms (1-9 employees); 32 small firms (10-49 employees); 34 medium firms (50-249 employees); 19 large firms (≥ 250 employees).

3.1 Measures

To test our conceptual model, we operationalized the variables as follow.

Dependent Variable. BMI is a dummy variable operationalized asking firms if they have changed or not their BMs, therefore those organizational and strategical structures allowing firms to generate value and achieve a competitive advantage (Pucci, 2016).

Independent Variables. Geographic [a], Technological [b], Organizational [c], and Social [d] Proximities are operationalized asking respondents to assess from 1 "no impact" to 5 "high impact" what is the influence on the relationships with their supply chain partners of: [a] geographic proximity; [b] existence and sharing of digital infrastructures; [c] share of a similar organizational culture; [d] trust based on long term relationships.

Mediating Variable. For what concerns TA, firms were asked to indicate if they have introduced during the period 2015-2017 the following technologies: (1) advanced manufacturing solutions, (2) additive manufacturing, (3) augmented reality, (4) simulation, (5) horizontal/vertical integration, (6) industrial internet, (7) blockchain, (8) cloud, (9) cyber-security, (10) big data and analytics (Piano Calenda, 2015). Each item is operationalized as a dummy variable (1 = "introduced" or 0 = "not-introduced"), thus TA was obtained as the arithmetic mean of the previous ten dummies.

Control Variables. To control for firms' Age and Size, we used the natural logarithm of the number of years since firm's establishment and number of employees, respectively. Furthermore, we asked firms to state if they are family firms (dummy = 1) or not (dummy = 0). Lastly, R&D was operationalized asking respondents to state the percentage of R&D over the total turnover.

Table 1 summarizes variables features.

Tab. 1: Measures description

Variables	Items	Source
Business Model Innovation (dummy, 1 0 "selected")		Our processing and adaptation starting from Pucci (2016)
Proximity Dimensions	*What is the impact of the following factors on the relationships among the actors of your supply chain?*	
Geographical Proximity (Likert scale 1-5)	Actors' geographical propinquity	
Technological Proximity (Likert scale 1-5)	Existence and sharing of digital infrastructures	
Organizational Proximity (Likert scale 1-5)	Share of a similar organizational culture	
Social Proximity (Likert scale 1-5)	Trust based on long term relationships	
Technology Adoption (dummy, 1 = "selected")	(1) Advanced Manufacturing Solutions; (2) Additive Manufacturing; (3) Augmented Reality; (4) Simulation; (5) Horizontal/Vertical Integration; (6) Industrial Internet; (7) Blockchain; (8) Cloud; (9) Cyber-security; (10) Big Data and Analytics	Piano Calenda, 2015
Control variables		
Age (log)	Natural logarithm of the number of years since the constitution	
Size (log)	Natural logarithm of the number of employees	
Family	Dummy, 1 = Selected	
R&D	Percentage of R&D expenditure on total turnover	

Source: our elaboration

3.2 Econometric Strategy

To test the impact of the independent variables over TA, we employed an OLS regression analysis since TA (obtained through the arithmetic mean of ten dummies) can be treated as a continuous variable. Whereas, BMI is regressed over the independent variables employing a Logit model since BMI is a dichotomous variable.

Mediation analysis is obtained through g-computation formula (Daniel *et al.*, 2011). We employed Model 1 for TA (see Table 3) and Model 6 (controlling also for the interaction term among TP and TA) for BMI (see Table 4), thus estimating the following regressions:

[1] $TA = \alpha_1 Age(log) + \alpha_2 Size(log) + \alpha_3 Family + \alpha_4 R\&D + \alpha_5 TP + \alpha_6 GP + \alpha_7 OP + \alpha_8 SP$

[2] $BMI = \beta_1 Age(log) + \beta_2 Size(log) + \beta_3 Family + \beta_4 R\&D + \beta_5 TA + \beta_6 TP + \beta_7 GP + \beta_8 (GP)^2 + \beta_9 OP + \beta_{10} SP\ (log) + \beta_{11} TA*TP$

To explain what g-formula package estimates, it is easier to decompose mediation analysis with counterfactuals (Daniel et al., 2011). Let's assume that X is a binary exposure variable, M a binary mediator, and Y an outcome variable. I our case, the formula gives three outcomes: the total causal effect (TCE), the natural direct effect (NDE), and the natural indirect effect (NIE). TCE compares E(Y[x, M(x)]) for different values of x:

TCE = E(Y[1, M(1)]) - E(Y[0, M(0)])

NDE is a comparison of E(Y[x, M(x_0)]) for different values of x, while x_0 is fixed at the baseline value:

NDE(0) = E(Y[1, M(0)]) - E(Y[0, M(0)])

Lastly, the NIE is obtained comparing E(Y[x, M(x0)]) for different values of x_0, while keeping x fixed: NIE(1)= E(Y[1, M(1)]) - E(Y[1, M(0)])

The g-formula infers TCE as described above, while for NDE and NIE it combines several simulations of M under different hypothetical values of X. Therefore, if X is binary, M is simulated for both X=1 and X=0.

In our case, X is not binary, but it is a categorical variable with baseline value equal to 1. In this case, the package compares this baseline value with the distribution of X. Additionally, it enables to control for confounders in both exposure-outcome and mediator-outcome relationships.

Computations were performed through Stata 14.2.

4. Results

Table 2 provides descriptive statistics and correlation analysis and Appendix 1 displays VIF scores and Tolerance levels. Low correlation levels (all lower than 0.5 in absolute value), together with low VIF scores (all equal or lower than 1.60) and good Tolerance levels (all greater than 0.62) guarantee the absence of multicollinearity among model variables (Kunter *et al.*, 2004).

Tab. 2: Descriptive Statistics and Correlation Analysis

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
[1] BMI	1.000									
[2] Age (log)	0.054	1.000								
[3] Size (log)	0.211	0.497	1.000							
[4] Family	0.003	0.059	-0.153	1.000						
[5] R&D	0.021	-0.274	-0.034	-0.219	1.000					
[6] Tech. Adoption	0.280	0.173	0.323	-0.205	0.167	1.000				
[7] Technological Prox.	0.232	0.111	0.161	-0.054	0.126	0.396	1.000			
[8] Geographical Prox.	0.003	-0.043	-0.032	0.065	-0.074	-0.140	0.153	1.000		
[9] Organizational Prox.	0.129	0.146	0.172	-0.076	0.051	0.175	0.389	0.029	1.000	
[10] Social Prox.	-0.069	0.224	0.047	0.046	-0.025	0.072	0.220	0.222	0.094	1.000
Mean	0.398	2.772	3.474	0.447	0.072	0.226	3.350	2.935	3.545	3.870
SD	0.492	1.065	2.119	0.499	0.101	0.186	1.287	1.158	1.073	1.116
Min	0	0	0	0	0	0	1	1	1	1
Max	1	4.796	10.215	1	0.8	0.7	5	5	5	5

Notes: N=123. Correlation coefficients greater than 0,2 in absolute value are statistically significant at 95%.

Source: our elaboration

4.1 Regression model

Table 3 displays results of TA regressed over the explanatory variables. In Model 0 only control variables are introduced, thus highlighting both Size and R&D to have a positive and significant influence on the dependent variable. Then, Model 1 introduces the independent variables: TP shows a positive and highly significant influence, while GP has a negative and significant effect. Moreover, while the effect of Size remains significant and positive, the coefficient of R&D loses both magnitude and significance. Both OP and SP have an effect not statistically significant. So, Hp.1 is partially supported as SP and OP do not have a direct effect on TA. Furthermore, we tested the ability of GP to moderate the effect of TP, OP, and SP on TA. As shown in Model 2, only the interaction term GP*SP has a significant and positive effect on the dependent variable. Hence, Hp.2 is partially supported since GP is not able to positively moderate TP and OP. Lastly, both Model 1 and Model 2 show good levels of R^2, thus highlighting a good model fit.

Tab. 3: Regression Analysis on Technology Adoption

	Technology Adoption		
VARIABLES	Model 0	Model 1	Model 2
Age(log)	0.0175	0.00874	0.00892
	(0.0172)	(0.0170)	(0.0170)
Size(log)	0.0228**	0.0195**	0.0197**
	(0.00878)	(0.00821)	(0.00813)
Family	-0.0499	-0.0461	-0.0496
	(0.0329)	(0.0305)	(0.0307)
R&D	0.320**	0.191*	0.203*
	(0.127)	(0.113)	(0.108)
Technological Prox.		0.0532***	0.0578***
		(0.0119)	(0.0123)
Geographical Prox.		-0.0282**	-0.108***
		(0.0117)	(0.0361)
Organizational Prox.		-0.00439	0.000115
		(0.0123)	(0.0127)
Social Prox.		0.00309	-0.0512*
		(0.0117)	(0.0279)
Geo. Prox. * Soc. Prox.			0.0204**
			(0.00926)
Constant	0.0979**	0.0490	0.225**
	(0.0474)	(0.0684)	(0.102)
Observations	123	123	123
R-squared	0.157	0.290	0.307

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration

Table 4 summarizes the logit analysis obtained regressing BMI over the explanatory variables. In Model 3 BMI is regressed over the four proximity dimensions. Only TP shows a positive and significant effect on the likelihood of having BMI, while GP, OP, and SP display a not significant effect. In Model 4 TA is introduced, thus showing a positive and significant coefficient. Moreover, it should be noted that TP coefficient loses its magnitude and the standard error increases, thus suggesting a mediation effect of TA over TP on BMI. In Model 5 and 6 we take into account nonlinear effects for GP and SP, improving the Pseudo R^2 from 0.109 to 0.165 and 0.166. Here, GP shows a strong inverted U-shaped effect over the likelihood of having BMI, while SP shows a negative linear effect improved in terms of significance after the log transformation. Here, TP acquires a positive and significant effect if compared to Model 4, while TA coefficient loses magnitude and the standard error increases. Thus, Hp.3 is supported, while Hp.4a is partially supported. Lastly, we investigated the moderating ability of GP over TP, OP, and SP: as shown in Model 7, only the interaction term GP*SP is statistically significant and curvilinear. Indeed, Figure 2 shows that for extreme values of spatial distance or proximity, the effect of SP on BMI is negatively moderated, while for medium-low to medium-high values of spatial proximity, the effect of SP on BMI is positively moderated. Hence, Hp.5 is partially supported.

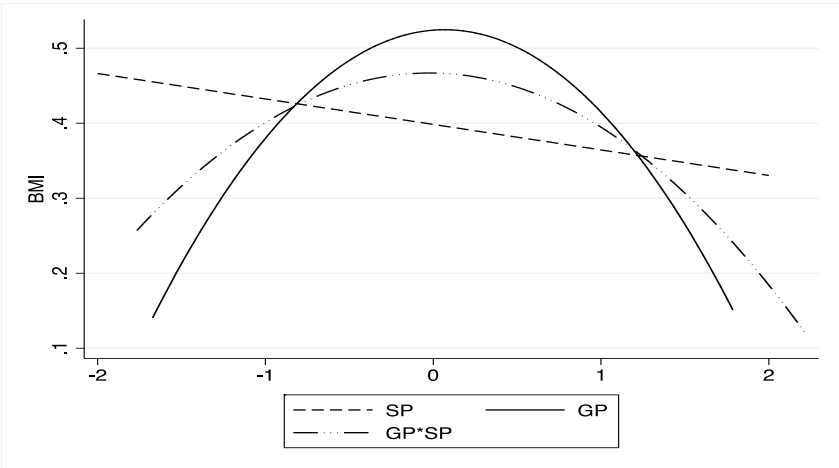
Tab. 4: Logit Regression Analysis on Business Model Innovation

	Business Model Innovation				
VARIABLES	Model 3	Model 4	Model 5	Model 6	Model 7
Age(log)	-0.134	-0.158	-0.157	-0.141	-0.148
	(0.230)	(0.229)	(0.253)	(0.255)	(0.256)
Size(log)	0.228**	0.188*	0.157	0.158	0.158
	(0.111)	(0.112)	(0.121)	(0.122)	(0.122)
Family	0.266	0.394	0.450	0.451	0.538
	(0.414)	(0.417)	(0.429)	(0.431)	(0.434)
R&D	-0.187	-0.654	-0.701	-0.614	-0.478
	(1.966)	(2.129)	(2.186)	(2.177)	(2.348)
Tech. Adoption		2.497**	2.448*	2.454*	2.534*
		(1.222)	(1.356)	(1.353)	(1.353)
Technological Prox.	0.405**	0.287	0.351*	0.370*	0.374*
	(0.174)	(0.191)	(0.202)	(0.205)	(0.214)
Geographical Prox.	-0.0204	0.0517	2.979**	3.019**	7.729**
	(0.168)	(0.180)	(1.163)	(1.182)	(3.062)
Geo. Prox. SQD			-0.484***	-0.490***	-1.336**
			(0.177)	(0.179)	(0.533)
Organizational Prox.	0.0950	0.106	0.107	0.0854	0.0724
	(0.199)	(0.199)	(0.211)	(0.211)	(0.217)
Social Prox.	-0.257	-0.276	-0.368*		
	(0.179)	(0.185)	(0.200)		
Social Prox. (log)				-1.092**	3.321
				(0.557)	(3.050)
Geo. Prox. * Soc. Prox. (log)					-3.674*
					(2.197)
Geo. Prox. SQD * Soc. Prox. (log)					0.653*
					(0.377)
Constant	-1.640	-1.820*	-5.441***	-5.557***	-11.13***
	(1.006)	(1.019)	(1.865)	(1.842)	(4.077)
Observations	123	123	123	123	123
Pseudo R2	0.0843	0.1096	0.1656	0.1662	0.1764

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: our elaboration

Fig. 2: Interaction effect on BMI



Source: our elaboration

4.2 Mediation analysis

Table 5 shows mediation analysis obtained through g-computation formula (Daniel *et al.*, 2011).

Tab. 5: Mediation Analysis

	G-computation estimate	Bootstrap Std. Err	z	P>|z|	Normal-based [95% Conf. Interval]	
TCE	.423	.054	7.90	0.000	.318	.528
NDE	.171	.057	3.01	0.003	.059	.282
NIE	.252	.066	3.79	0.000	.122	.382

Source: our elaboration

The mediation analysis results show that both total causal effect (TCE), natural direct effect (NDE), and natural indirect effect (NIE) are significant. From TCE, we can conclude that TP has a causal effect on BMI. Indeed, if TP is equal to 1 (baseline value), the likelihood of having BMI would decrease of 0.423; a large part of this reduction is mediated by TA, 0.252. Therefore, we can conclude that TA is able to mediate the effect of TP on BMI.

We tested mediation also for SP and OP, obtaining not significant results. Consequently, Hp.4b is supported only in the case of TP.

5. Discussion and conclusion

Focusing on the role of both technological and non-technological factors, this research offers some intriguing findings for both theory and practice.

For what concerns TA, having a strong relation (SP) with supply chain partners *per se* is a not sufficient condition. However, if that relationship goes with face-to-face contact, its effect becomes relevant. Indeed, the introduction of new technologies is negatively influenced by long-term relationships, but if that exchange of knowledge or advices happens in close proximity, the negative effect is smoothed. This result is in contrast with Feldman et al (2015) that emphasized the crucial role of social connections in fostering technology diffusion. Additionally, sharing similar digital infrastructures (TP) with supply chain actors enhances firms' ability to adopt new technologies. Indeed, to use such infrastructures, firms need a specific technical knowledge and practical understanding of that knowledge. Hence, having in common such a specific knowledge and experience base enables firms reciprocal understanding (Zeller, 2004). Moreover, a strong negative effect on TA is exerted by spatial closeness (GP). This result suggests that actors facing high GP with partners are less likely to introduce new technologies, falling in a lock-in effect and technological redundancy.

For what concerns BMI, its relationship with technological and non-technological variables is more complex, involving both linear and non-linear effects. Having adopted new technologies, firms are more prone to modify their BM to efficiently tackle the technological challenge faced. This result is in line with previous researches on BMI (Rayna and Striukova, 2016; Li, 2018; Müller *et al.*, 2018). Additionally, actors that share too strong relationships with supply chain partners are less likely to engage in modification of their BM. This negative effect is partially smoothed by face-to-face contacts and only for medium values of both SP and GP. This negative effect may be explained by bounded rationality of actors that push them to search for new knowledge and technical advices among socially closer partners, that are more likely to share similar values, knowledges, and routines. This unconscious custom may increase the likelihood of lock-in effect, knowledge redundancy, thus hindering innovation. Moreover, actors that share digital infrastructures are more likely to engage in the reshaping of their BM. However, this effect is largely indirect, thus driving BMI across the introduction of new technologies. Therefore, TP is beneficial for both TA and BMI. Lastly, actors displaying too high or too low values of spatial closeness with supply chain partners are less likely to innovate their BM. This inverted U-shaped effect fits perfectly the theoretical assumption discussed by the literature (Boschma, 2005).

Sharing a final thought on the effect of OP, thus the sharing of a similar organizational culture, it is worth. Indeed, OP has a not significant effect on both TA and BMI, something unexpected if compared to previous results on collaboration networks and innovation (Marrocu *et al.* 2013; Geldes *et al.*, 2017). The reason for this may depend on the timing of this research. Indeed, as underlined by Feldman *et al.* (2015) the impact of proximity dimensions may change not only over industry but also over time. Indeed, we are facing the first steps towards a digitalization process that is calling economic actors to completely reshape not only their organizational structure, but also values, customs, culture, and so forth. Therefore, OP may result not significative for TA and BMI, since firms are unconsciously facing a modification process that is ongoing. Perhaps, to share a common organizational culture is still a latent firms' need for cooperation and partnership agreements, that may become expressed when digitalization and Industry 4.0 will actually spread. We leave this topic open for further research.

This paper provides interesting contributions to theory and literature on business model innovation. First, studies on business model innovation in Industry 4.0 are still in their embryonic stage and, albeit initial evidence has emerged, it is mainly qualitative in nature. Hence, our paper presents some first empirical quantitative evidence treating BMI as the *outcome* (Foss and Saebi, 2017), rather than a process (e.g. Sosna *et al.*, 2010), and showing whether a technological determinant, i.e. Industry 4.0 technologies adoption, has an impact on BMI. Then, we looked at an under researched non-technological *determinant* of BMI, that of proximity dimensions. This provides a first quantitative evidence of the influence of proximity on BMI, thus enriching the previous qualitative contribution of Mason and Chackrabarti (2017). Thirdly and foremost, this research gives a partial support to the theoretical intuition of Boschma (2005), showing that being geographically close or distant could influence the effect of at least SP. This provides an interesting contribution in the context of Industry 4.0 and requires further investigation. As a matter of fact, whether on the one side technologies 4.0 may express their full potential once adopted along the entire supply chain., our results suggest that companies need to pay attention to being too much geographically close and socially proximate. Indeed, having strong relationships with upstream and downstream partners is not enough in adopting new technologies and it leads to lower business model innovation. However, geographical proximity plays an important role in influencing these relationships. It is only when social relationship goes with face-to-face contact, that its effect becomes relevant as shown by our findings. Companies face lot of internal obstacles in adopting new technologies even when adopted by their partners. One of the reasons may reside on their perception as highly risky technologies, especially in the case of smaller firms. However, when socially proximate companies are also geographically close, the adoption of new technology may be facilitated. In other terms, when companies are able to touch and see their partners' technologies, having face-to-face contact with their partners, they are more prone to adopt them. In addition, being too little (much) geographically close and too little (much) socially proximate could damage business model innovation. To the best of our knowledge this is the first contribution that emphasizes the importance of balancing proximities dimensions in improving business model innovation.This research has also some crucial managerial implications. Firstly, in a changing technological environment that is going towards a deep modification of the industrial system (fourth industrial revolution), firms should invest on knowledge. Hence, economic actors should try to acquire that knowledge both outside firm boundaries (e.g. collaborations with Universities or research centers; hiring highly skilled and well-trained employees) and inside (e.g. training courses for both managers and employees). Secondly, firms should invest on new technologies, thus boosting internal stirring and avoiding falling in myopia and inertia. Thirdly, actors should avoid looking for knowledge and technological advices solely among socially close partners. Indeed, overcoming this cognitive constraint may enhance the access to new and strategic knowledge that will translate in organizational renewal. Lastly, even though globalization and transport improvements lowered the significance of physical boundaries, economic actors should still pay attention to maintain both local relationships and distant ones strategically crucial. Therefore, firms

should actively manage their relationship balancing not only local and distant relations, but also local and distant knowledge.

Nonetheless, this research has also some policy implications. A first consideration is linked to the relationship between size and technology adoption: our findings suggest that larger firms have a higher propensity to adopt new technologies than smaller ones. This evidence supports the need to develop regional policies in favor of small and medium-sized firms (that constitute the main business archetype of Italy), thus enabling them to catch up with the latest technological challenges. Furthermore, since technological proximity results from investments in education and, in particular, in the so-called STEM (Science, Technology, Engineering and Mathematics) disciplines, policy makers should direct higher investments towards education and learning. Finally, the new challenge offered by Industry 4.0 and digitalization is calling not only for capable managers, but also for public administrators able to understand and lead local context towards this challenge. Supporting education and boosting collaboration among local and distant stakeholders is a "must" for local administrators.

This research is not without limitations. Indeed, our study does not consider the multi-dimensional nature of each proximity dimension since our operationalization relies on single-item scales. Moreover, our firms belong to multiple sectors and we have not employed sector dummies to control for sectoral specificities. Lastly, the choice of an Italian sample represents a limitation that may hinder generalizability, thus calling for a comparison at international level.

Appendix

Appendix 1: VIF and Tolerance levels

	TA Regression		BMI Logit	
Variable	VIF	Tolerance	VIF	Tolerance
Business Model Innovation			1.16	0.8634
Technology Adoption	1.41	0.7103	1.46	0.6857
Age (log)	1.59	0.6288	1.60	0.6265
Size (log)	1.50	0.6659	1.53	0.6518
Family	1.12	0.8951	1.13	0.8887
R&D	1.20	0.8367	1.20	0.8359
Technological Proximity	1.47	0.6786	1.50	0.6673
Geographical Proximity	1.14	0.8782	1.14	0.8773
Organizational Proximity	1.21	0.8294	1.21	0.8284
Social Proximity	1.16	0.8590	1.18	0.8463

Mean VIF = 1.31 Condition Number: 17.5181 (TA Regression); 18.0623 (BMI Logit)

Source: our elaboration

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Industry 4.0 technologies and servitization strategy: a good match?♦

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Abstract

Objectives. *The paper aims at investigating whether a relationship exists between servitization strategy and the adoption of Industry 4.0 (I4.0) technologies among small and medium sized enterprises (SMEs) operating in B2B context.*

Methodology. *Case study method based on in-depth interviews with entrepreneurs and managers of 7 SMEs operating in the mechanical sector in Italy*

Findings. *The article provides some preliminary evidence on the interplay between some I4.0 technologies (Internet of Things, Cloud, Simulation, Big Data and Analytics) and servitization strategies of B2B SMEs, and highlights some performance implications. The authors propose three research propositions to be tested in future researches.*

Research limits. *Although the goal of the research is exploratory, it is worth to mention that it considers a small sample of B2B SMEs operating in the metals and machinery sector. Future studies could investigate these relationships among larger samples of cross-sectional companies.*

Practical implications. *This work identifies a selection of technologies belonging to I4.0, which can be coherent with each other and functional to the implementation of a servitization strategy of SMEs.*

Originality of the study. *This work contributes to servitization literature, by investigating the role of I4.0 technologies. Also, it contributes to management literature, by offering a first empirical evidence of Italian manufacturing SMEs that have adopted I4.0 technologies.*

Key words: *Industry 4.0; digital technologies; servitization; performance; B2B; SME.*

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1. Introduction

Digitization connects people, companies, systems, products and services (Coreynen, Matthyssens and Van Bockhaven, 2017), opening opportunities for new ways of doing business, with potential strong impacts especially in the manufacturing context (Rymaszewska *et al.*, 2017). Indeed, digital technologies can provide critical support to innovation and marketing strategies, but can also enable firms to organize and manage their business in a completely different way. In particular, in the digital era, scholars and practitioners have attributed to Industry 4.0 (I4.0) technologies a disruptive power, which could dramatically impact on industries and competition on the one hand (Porter and Heppelmann, 2014; Vendrell-Herrero *et al.*, 2017), and on organizations themselves on the other hand (Porter and Heppelmann, 2015). Indeed, from this second point of view, I4.0 technologies can be implemented in different activities of the value chain, with potential impacts at different levels, from inbound logistics to post-sale assistance (Porter and Heppelmann, 2015).

I4.0 technologies are also expected to enable and/or support the servitization of manufacturers (Kamp and Parry, 2017). Such relationship is getting steam in the literature, but remains largely under-explored from an empirical point of view (Kowalkowski *et al.*, 2017; Paiola, 2017). An exception in the manufacturing context is the study by Coreynen, Matthyssens and Van Bockhaven, (2017) that shows that specific digital technologies can lead companies to different servitization pathways, but require a dynamic configuration of the firm's resources. Despite such attempt, at the best of our knowledge, no empirical studies have tried to investigate whether - and how - I4.0 technologies enable or support servitization strategies among manufacturing firms. Moreover, assuming that this relationship exists, it becomes crucial to understand to what extent firms really benefit from the synergies it can deploy in terms of performance (Paschou *et al.*, 2017; Rymaszewska *et al.*, 2017).

This paper aims to contribute to fill this gap and deepen the relationship between I4.0 technologies, servitization strategies and performances of firms operating in the business-to-business (B2B) market context. In fact, I4.0 technologies are expected to pave the way to profound innovations in the way B2B firms organize their businesses (Paschou *et al.*, 2017). In particular, a transition from product-based to service-centric business models - or an acceleration of already on-going transitions - is expected (Vendrell-Herrero *et al.*, 2017; Kamp and Parry, 2017; Coreynen *et al.*, 2017).

Furthermore, considering just the issue of servitization, a multi-sided framework is emerging, in which the intensity and the role played by services can vary a lot among sectors, and also between firms belonging to the same sector (Cusumano *et al.*, 2015; Rymaszewska *et al.*, 2017; Vendrell-Herrero *et al.*, 2017). Moreover, recent surveys have shown that the transition from product- to service-based business models can be less easy as would be expected for companies undertaking it (Baines *et al.*, 2017; Paiola, 2017). In this respect, some studies have shown that servitization can be a profitable competitive strategy in particular conditions (Lee *et al.*, 2016), whereas other works have highlighted a negative relationship between servitization and performance (Saccani *et al.*, 2014), and other works have underlined that this relationship is moderated by other factors (Zhen, 2012). In this articulated framework, it becomes even more important to understand which role could have I4.0 technologies in the servitization of manufacturing (Paschou *et al.*, 2017).

Through qualitative methodology, this study contributes to this discussion by analyzing a sample of SMEs operating in B2B context. The purpose of the research is to answer the following research questions: are I4.0 technologies enabling or accelerating the (on-going) transition from product- to service-based business models in B2B firms? If so, could this have an impact on firm performance?

To this purpose, we adopt a case study method (Eisenhardt, 1989) based on in-depth interviews with managers and entrepreneurs of 7 SMEs operating in the mechanical sector. In particular, this research seeks to understand whether I4.0 technologies - and which ones specifically - can boost the

servitization strategies of SMEs, how such interplay happens and, eventually, what are the performance implications of this interaction.

This work contributes to the literature on servitization strategy by clarifying the role played by I4.0 technologies in the deployment of servitization strategies and by discussing the outcomes of such joint effect in terms of firm performance.

The article is structured as follows. The second section provides an overview of the literature. The third one clarifies the methodology used. Then, in the fourth, we present the cross-case analysis and we discuss results in the fifth section. Research and managerial implications, and limitations of the study conclude this paper.

2. Literature review

2.1 The evolution of services in B2B contexts

If we look at the evolution of the managerial literature on buyer-supplier relationships, we will notice that such debate has mostly assumed the perspective of client firms (e.g. Dwyer, Schurr and Oh, 1987; Zhao and Cavusgil, 2006). Such vast literature had the merit to highlight the many advantages stemming from the collaboration between clients and supplying firms operating in B2B, such as speeding-up the time-to-market of clients, reducing errors and related costs, increasing product quality, etc. (e.g. Sako and Helper, 1995; Dyer and Singh, 1998; Kotabe, Martin and Domoto, 2003). However, B2B companies have not been passive - or just reactive - in this process. On the contrary, a parallel but minority literature has highlighted the active role played by suppliers and subcontractors in supporting the many achievements - in terms of innovation, quality improvements, cost reduction, etc. - obtained by client firms (e.g. Nassimbeni *et al.*, 1996; Kindström and Kowalkowski, 2014; Carbonell and Rodriguez-Escudero, 2014; Gremyr *et al.*, 2014; Von Koskull and Strandvik, 2014; Mustak, 2014). As Furlan *et al.* (2007) observe, firms operating in B2B have assumed more and more design responsibilities over time and have been substantially helping their clients in designing better and/or more efficient products and processes. More in general, over time, suppliers and subcontractors operating in B2B, have gradually abandoned a mere productive (and reactive) role and started being more and more proactive in providing their customers with a wide array of extra services - including *just-in-time delivery*, total quality assurance, co-design, etc. - that complement the supply of components, semi-finished products or machinery (Grandinetti and Bortoluzzi, 2004; Chiarvesio and Di Maria, 2009). As a result, the distinction between products and services has progressively blurred in the B2B context.

Vandermerwe and Rada (1988) first described this phenomenon and coined it as “servitization” of business. Since then, the literature on servitization has significantly grown crossing the one on buyer-supplier dynamics (Lightfoot *et al.*, 2013; Baines et al, 2017; Bustinza *et al.* 2017). Servitization has come in many fashion for firms. Oliva and Kallenberg (2003) talk about a product-service continuum, where traditional manufacturing companies only offer services as add-ons to their products, through to service providers where companies have services as the main part of their value creation process. Cusumano *et al.* (2015) highlight three categories of service for a product firm: those that “smooth” the product sale or usage without significantly altering the product functionality, those that allow the adaptation of the product to specific conditions, by expanding its functionalities; services that replace and are sold instead of the product. In the same vein, Kowalkowski *et al.* (2017: 9) recently distinguishes between a “service infusion” strategy - defined as the “process whereby the relative importance of service offerings to a company or business unit increases, amplifying its service portfolio and augmenting its service business orientation” - and a strategy of pure servitization, corresponding to “transformational processes whereby a company shifts from a product-centric to a service-centric business model and logic”.

The recent interest of academia towards services and servitization strategies in B2B is mainly due to the belief that through services firms can defend themselves from competition based in lower

cost economies, because services are more difficult to imitate and have increasingly become the source of competitive advantage for companies (Kamp and Parry, 2017). Indeed, service-based strategies are "distinctive, long-lived, and easier to defend" (Baines *et al.*, 2009, p. 547). Thus, services can be used to glue business relationships with main clients -by creating lock-in effects - and hence laying the basis for (more) sustainable competitive advantage in the long run.

Advantages and drawbacks of service-based strategies have been discussed as well in the literature (Baines *et al.*, 2009; Neely, 2008) and include, financial benefits (more stable revenue streams and higher profits), strategic benefits (services provided are tailored around the specific needs of business clients and hence difficult to imitate), marketing benefits (higher client retention is achieved) and environmental as well (less waste is produced, since production activities are streamlined along the supply chain). Of course, costs and drawback come as well with benefits, particularly for SMEs (Coreynen *et al.*, 2017). And mainly, the difficulties in managing the transition from products to services and in exploiting their full potential (Mathieu, 2001; Neely, 2008; Baines *et al.*, 2009; Paiola *et al.*, 2013; Zhang and Banerji, 2017). At this regard, Gebauer *et al.* (2005) discuss a potential "service paradox" that happens when firms invest heavily in extending the service business, but increasing services just create additional costs and do not generate the (expected) correspondingly higher returns.

2.2 Industry 4.0 technologies, digitization and servitization

Since digital transformation has recently become a hot topic in relation to manufacturing activities and B2B firms, academics have shown new potential connections between service-based strategies and the digital transformation of business (Porter and Heppelmann, 2014; 2015; Rymaszewska *et al.*, 2017). As Neil Gershenfeld said in 2012, "A new digital revolution is coming, this time in fabrication". A revolution that is headed by specific technologies, like additive manufacturing, big data and analytics, collaborative robots, advanced simulation, augmented reality, Internet of Things (IoT), cybersecurity, cloud computing (Rüßmann *et al.*, 2015), all grouped under the definition of "Industry 4.0". We refer to a bundle of heterogeneous technologies, which are associated with the ability to enable and accelerate the digital connection between products, processes, activities, and firms and that should lead manufacturing towards the so-called Fourth Industrial Revolution.

In Europe, Germany has been the leading country in supporting investments by private firms in such technologies. Since then, the word "Industrie 4.0" (in German) - or "Industry 4.0" (in English) - has become a common one to identify a wide array of enabling technologies that are expected to radically change the processes of value creation in intermediate markets (Kagermann, 2015) and, as a consequence, the business model of firms (Burmeister *et al.*, 2016; Westerlund *et al.* 2014). Not to speak of the whole competitive environment and economic rules (Weller *et al.*, 2015).

Recent studies have started to address the managerial side of the adoption of these new digital technologies (Liao *et al.*, 2017; Lu, 2017). In particular, Bauer *et al.* (2016) identified several possible impacts including the increase of productivity, the rise of product quality and process efficiency, superior flexibility, time-to-market reduction, environmental sustainability, new role of the consumer and, last but not least, a profound impact at the business model level (Lacy and Rutqvist, 2015; de Sousa *et al.*, 2018). Another expected impact of I4.0 is the increase of servitization strategies carried out by firms (Rymaszewska *et al.*, 2017). In fact, suppliers can leverage some I4.0 technologies to improve the existing service offering, whereas other technologies can be used to deliver new services (Rüßmann *et al.*, 2015). This might be the case of big data analytics, for instance, which could be offered as a new instrument in support of decision making (Rüßmann *et al.*, 2015). Another example regards the inclusion of advanced sensors in products - the Internet of Things (IoT). The latter can allow suppliers to manufacture smart and connected products that are expected to have a strong impact, not only at the product level, but also in terms of system of services (like remote assistance, predictive maintenance, data production and storage, etc.) (Porter and Heppelmann, 2014; 2015). Moreover, the combination of some I4.0

technologies, such as e.g. IoT and cloud, can allow manufacturers to draw on real-time data from the use of products and to provide new value-added services for their customers, with strong impacts on after-sales services (Bauer *et al.*, 2016).

However, I4.0 technologies are various and can be implemented in different business functions, with different impacts. In particular, an incremental and synergic use of these technologies can empower the outcomes achieved, because what really lays the foundations for the Fourth Industrial Revolution, which follows the third one driven by ICT and the internet, is connectivity among actors, objects, companies, systems, products and services (Coreynen *et al.*, 2017; Porter and Heppelmann, 2014). This, though, could become more difficult for established manufacturers, rather than start-ups and niche players, because digital skills and smart value propositions become more important to obtain profits through an increase of service offered (Bechtold *et al.*, 2014). Indeed, most studies and reports suggest that the real disruptive effect of I4.0 can be obtained through the simultaneous use of several technologies, which could allow companies to deliver smart, complex services and, eventually, move to a pay-per-use servitization strategy with a clear value-proposition that captures the value offered through additional and smart services offered (Bechtold *et al.*, 2014). In some cases, the use of I4.0 technologies can entail the possibility to generate new business models where users have no need to buy a product, but can simply access and use it - for instance, through the access to digital platforms (Bauer *et al.*, 2016). At the same time, it is not said that each I4.0 technology necessarily leads to an increase in the service offering or enable a servitization strategy. For this reason, it becomes important to explore and understand which I4.0 technologies could be adopted to this purpose.

3. Research method

The purpose of this study is to investigate the interplay existing among I4.0 technologies, servitization strategy and performance of B2B firms. To this purpose, we developed a multiple case study method (Eisenhardt, 1989). The nature of this study is exploratory. We obtained qualitative data through in-depth interviews with entrepreneurs and managers of 7 SMEs. Data were collected between September 2017 and June 2018. We adopted a purposive sampling approach to select B2B SMEs in the North-East of Italy, operating in the mechanical sector. The selection process benefited from the assistance of experts working in local technology transfers and the mechanical cluster, who helped investigators in the identification of SMEs that had adopted at least one I4.0 technology. Companies responded to the European definition of SME (European Commission Recommendation 96/280/EC: <250 employees and turnover <50 million Euro).

We collected in-depth interviews based on a semi-structured questionnaire with entrepreneurs and managers, with questions pertaining to I4.0 technologies adopted, firm and servitization strategies, product, and sector. Each interview lasted between 1 and 2.5 hours and involved at least two investigators. We decided to involve multiple investigators, because when observations of multiple investigators converge, the confidence in findings generally increases (Eisenhardt, 1989). We collected follow-up telephonic interviews, and press and archival documents for triangulation purposes. Interviews were taped and transcribed, producing a total of 12.5 hours of tapes and 30 pages of transcripts. Archival data and press were used for triangulation purposes. Table 1 describes the number and typology of interviews per company, whereas Table 2 provides information about selected cases.

Tab 1: Data collection process

Case	C1	C2	C3	C4	C5	C6	C7
Respondents	Founder-entrepreneur	Founder-entrepreneur & Operations Manager	Founder-entrepreneur	Founder-entrepreneur	Entrepreneur & Board Member	CEO	Founder-entrepreneur
Data collection process	Interview lasted 2.5 hours + production site visit	Interview lasted 1.5 hour + production site visit	Interviews (2) lasted 2 hours and 1.5 hours + client's production site visit	Interview lasted 1.5 hour + production site visit	Interview lasted 1.5 hour + production site visit	Interview lasted 2 hours + production site visit	Interview lasted 1.5 hour

Source: Our elaboration

Tab. 2: Case description

Case	C1	C2	C3	C4	C5	C6	C7
Age	40	22	32	22	58	8	10
Turnover 2016 (M Euro)	18	17	10	7	20	6	2.5
Employees	80	45	30	32	50	30	10
Foreign sales on total sales (%)	80	90	40	50	90	75	85
Product	Saws	Wire Rolling Technology	Beverage machines / plants	Mechanical machinery	Coating equipment	Programmable ovens	Machines

Source: Our elaboration

4. Cross-case analysis

As illustrated in table 3, manufacturing companies in our sample have selected some I4.0 technologies consistently with their overall strategy, with their resources, and product and process attributes. Firms have generally adopted I4.0 technologies to become more competitive in an environment that they perceived as dynamic and challenging. I4.0 technologies led them to obtain different outcomes (e.g. process innovation with an increase of efficiency and productivity; product innovations through, for instance, IoT; increased offering of new, complex services to customers).

The adoption of some I4.0 technologies is associated with service growth, as companies started offering new or additional services (e.g. simulation offered in pre- and post-sales; IoT exploited to offer specific remote post-sales assistance). However, in most cases, these technologies have boosted up an already existing trend of service growth. Established manufacturers in the sample started to increase service components in the Nineties, long before adopting the more recent I4.0 technologies. In contrast, the business idea of younger companies (C6, C7) was based on selling innovative products that - through the use of specific technologies such as IoT and the cloud - could offer additional, complex, smart services as part of their offering.

All manufacturing firms considered the service growth as a key element of their competitive strategy, in response to a growing competition deriving from - for instance - low-cost countries. Indeed, additional services were key attributes of their differentiation strategy.

In recent years, service growth related to I4.0 technologies has generally helped firms to increase the overall value offered to the market, because companies started offering new value-added services. This led to different outcomes. For instance, C1 noted that some additional services offered through these technologies have strengthened the relationship with some customers.

"Simulation service has helped us to increase customers loyalty. Some clients (e.g. machine builders) started to involve us in the design of their new products, with a co-design logic". - the founder of C1.

The level of service growth is heterogeneous (stronger or weaker) among sampled companies. Whereas most companies have translated the service growth in service infusion, two companies (C3, C7) have been experimenting a complex business model evolution towards a servitization logic. As an entrepreneur noted, C3 has approached a shift to a service-centric business model about 10 years ago, but the change is not yet concluded:

"Over the years, the company has evolved adding more and more machines types to its offering. We have always invested in technology. About ten years ago, we started including sensors in our products and - thanks to this - offering services of remote assistance. Now, we commercialize turnkey plants, which are now vertically and horizontally integrated. In this case, the plant consists of interconnected machines, which are connected to the manufacturer's cloud and the customer. Now, thanks to IoT, cloud and big data collection, we now offer real-time remote monitoring and management of plants. For a selection of customers, we do servitization: they buy service packages, while we keep the ownership of plants. At this stage, our business model is changing now towards a servitization logic, but it has not been a linear process so far." - The founder of C3.

For sure, in all cases, manufacturing companies used some I4.0 technologies, namely IoT, Simulation, Cloud and Big Data collection and analytics, to offer new or additional services. For instance, simulation has been used to offer pre-sales services (e.g. more accurate cost estimates, waste reduction, problem solving in prototyping…) (C1, C2, C4, C5), but even for post-sales assistance (e.g. to monitor performance of machinery, to simulate the use in different conditions or with different tools, etc.) (C2). As regards IoT, this technology built the foundations for creating smart products that could potentially or eventually be connected to the manufacturer (C2, C3, C4), the cloud (C3, C5, C6, C7), customers via app (C6, C7) or to platforms (C7). The cloud was widely adopted to share a virtual storage space with customers, in order to offer new additional post-sales services (e.g. remote monitoring, storage of certifications and information about finished products, direct download of clients' orders through Electronic Data Interchange (EDI) systems, etc.). The cloud was often associated with the adoption of IoT in the case of manufacturers of machinery or smart connected products. About big data collection and analytics, companies encountered more difficulties in implementing this technology, which is often directed to analyze data on products' usage or features, responding to product innovation purposes (C1) or to enrich service portfolio (C3, C6, C7). An exception is the young company C7, because since the beginning the founder identified a group of technologies that could - all together - enable the offering of new, smart services. In this case, besides IoT and the cloud, the founder already had a clear idea on how to develop big data and analytics. Since the beginning, C7 conceived a smart product, which was supposed to be connected to the manufacturer's cloud and customers via app in order to let them collect and monitor data on energy consumption and related costs. Now, the company has been developing a pay-per-use strategy, where customers can share the product with other people with a sharing economy logic. However, this strategy is still in a developing phase.

More interestingly, among companies that have already developed a servitization strategy, the adoption of I4.0 technologies was finalized to a planned increase of services offered to customers. In most cases, the adoption process reflected an incremental approach, but in rapid evolution. As a result, after implementing one technology aimed at offering a specific service, most companies rapidly understood potentialities of other related I4.0 technologies that could enhance or enrich the service offering. From this perspective, through a simultaneous and combined adoption of I4.0 technologies, which was aligned with the firm strategy, companies were able to obtain positive returns from the servitization strategy. This is the case of companies C3 and C7.

Overall, firms have generally underlined difficulties in exploiting the full potential of service growth. Frequently, customers do not recognize the value of additional innovative services connected with smart products, are not able to exploit the advantages of remote assistance or simply are not willing to pay additional price for these services.

As C6 noted:

"The company is developing a smart oven that could be remotely monitored and managed by us and connected to our cloud. The connection to the cloud has been planned to increase the service offering embedded in the product. However, service growth entails a lot of challenges, such as

critical aspects on how to manage data, privacy issues and cybersecurity. Once these issues will be solved, we expect that the creation of smart, connected products will give us the opportunity to offer a wide range of after-sales services that will be added to the product itself. For instance, this technology allows the company to enter the habits of the users through the collection and analysis of usage data." - The founder of C6

Always in the machinery context, C4 has underlined other difficulties in exploiting the full potential of innovative services:

"Frequently, customers do not recognize the value of additional services such as remote assistance or they are not able to exploit the potentialities of smart products. In other cases, customers are not ready to share sensitive data such as the ones related to their production processes, but this is absolutely necessary to exploit the advantages of remote assistance." - C4's founder.

Another challenge relates to the unwillingness of customers in buying innovative services obtained through I4.0 technologies as a separate offering or simply paying extra-costs for them. Some firms have experimented commercial solutions that can help customers to understand the value of services, aimed at reducing customer's reluctance to use and pay for them. For instance, C5 is evaluating the possibility of selling remote assistance as an independent service that the customer could eventually decide to buy (or not) when buying the coating equipment. Also, C2 is defining on a solution to sell its simulation software:

"After the purchase of our machinery, our customers can use our simulation software for free for one year long. Then, the customer can eventually decide to buy the license to keep using the software longer." - C2's founder.

Instead, C3, which has adopted I4.0 technologies coherently with a servitization strategy, is the only one that has defined an explicit pricing strategy to sell its services.

"To some MNEs and large clients, we give machines on a gratuitous loan, but ask a fee to use them. In these cases, we maintain the ownership of the plant and remotely manages it from our headquarter, while the customer has just the right to use it in the face of a usage fee. This represents a complete business model shift, compared to our past. Now, we offer useful, innovative services, and profitability largely depends on them." - the founder of C3.

The exploitation of innovative services seems to call for a need of learning and experimentation that should involve not only the manufacturing firm but also its customers. In contrast, C7 is developing a digital platform on which the firm could base the development of a servitization strategy, responding to a sharing economy logic. This young company was born on the idea of selling products that - through a combination of I4.0 technologies - can offer complex services, where the competitive advantage of the firm is settled. Although this combination of I4.0 and servitization allowed the firm's growth, still the implementation of a comprehensive servitization strategy requires an entire rethinking of the firm positioning and an accurate identification of segments that could be served.

Tab. 3: Cross-case analysis in terms of I4.0 technologies and service processes.

Case	Service path	I4.0 technologies adopted	I4.0 technologies enabling firms to offer new or additional services
C1	Over the last decades, the firm has developed a service infusion strategy, which has strengthened the firm's competitive advantage.	Advanced robotics, cobots, and interconnected machines, aimed at achieving vertical integration to increase efficiency of plants, reduce costs, improve lead times and increase the flexibility of production. Simulation used in prototyping to improve the production process and offered as a service in pre/post-sales. Big data collection and analytics in progress - related to the utilization of the tool - with the purpose of further improving product performances.	*Simulation, Cloud, Big data collection and analytics:* the adoption of simulation has reinforced the already existing trend to service growth. Simulation service is particularly appreciated by some customers that have started to collaborate more intensely with the firm. The firm aims to further exploit the potentialities of this service; now, this service is offered as an add-on to physical products, rather than separately paid.
C2	Since the establishment of the company, services have represented key components of the offering.	Simulation used at the design stage and offered to customers as post-sales service. IoT applied to smart products.	*IoT, Simulation:* I4.0 technologies are adopted to introduce product innovations. A simulation software is offered to customers. The firms is exploring commercial solutions to exploit the commercial value of the simulation service.
C3	Since the beginning, service infusion has characterized the evolution of the firm's offering. About 10 years ago, the firm began transforming its business model towards a servitization strategy.	Robots in production to reduce the costs of production. IoT fully implemented to create smart and connected plants, which are vertically and horizontally integrated. The first one entails that the whole production process is made of interconnected machines, which are connected to the different value chain activities of the company (from orders to post-sales). Also, plants are horizontally integrated as the manufacturer remotely controls, monitors and manages the plants for its customers.	*IoT, Cloud, Big data collection and analytics:* the adoption of I4.0 technologies is associated with service growth through not only "service infusion" but also an explicit "servitization" strategy. In this case, I4.0 technologies have enabled new services (e.g. remote control), thus driving the firm to experiment a business model evolution towards "servitization".
C4	Since the foundation, service infusion has characterized the evolution of firm's offering. Over the last years, the firm has increased the service component in response to growing competition.	Simulation used at the design stage to improve the subsequent production process. IoT applied to the product: smart and connected products, where connectivity is offered mainly as a service of remote diagnostics with international customers.	*IoT, Simulation:* I4.0 technologies (e.g. simulation, smart product) are boosting up the process of "service infusion". The adoption of I4.0 technologies represented a means to improve products and eventually increase sales. Very frequently customers underestimated and underused potentialities of smart products. The firm considers the production and the adoption of I4.0 technologies as a "learning process" that involves both the firm and the clients.
C5	Service infusion has gradually increased over last 20 years. The firm has been gradually developing new, complex services, which could be the base to transform their business model in a servitization logic.	Simulation used in the designing phase to improve both the product and the production process. Smart and connected products that make available remote diagnostic. Cloud used to offer remote software management to customers.	*IoT, Simulation:* some smart products' potentialities are not fully exploited. For example, remote assistance is available in smart equipment, but it is not requested by customers. The firm is looking for a "commercial formula" to obtain higher returns from smart products. It is evaluating the possibility to sell remote assistance as an independent service that the customer can decide to buy (or not) when buying the coating equipment.
C6	Since the establishment, complex services have been key components of the firm's differentiation strategy.	IoT related to the creation of smart and connected products that are sold globally. Products include sensors and are connected to the manufacturer, the app (international costumers) and the cloud.	*IoT, Cloud, BD collection (WIP):* Smart products could increase the service offering embedded in the product. However, service growth entails challenges that the firm is trying to overcome.
C7	Since the establishment, products have been developed to exploit and offer complex services, which are key components of the firm's offering. The firm has approached a servitization strategy, which should let most profits be obtained through post-sales services.	Product embedding sensors and cyber physical systems (IoT), which are connected to the cloud and allow big data collection and analytics. A further connection would be developed to connect products with a digital platform.	*IoT, Cloud, BD collection and analytics:* Smart connected products embedding a key service component in the offering. The firm has developed a product that already embedded high technological component, and -since the beginning- targeted selected technologies in order to increase the service component offered. The adoption of IoT, Cloud, Big data collection and analytics was rapid and coherent with the servitization strategy of the company. Further potentialities in terms of technological boost of service offering were discovered later on.

Source: Our elaboration

5. Discussion

The cross-case analysis has provided some preliminary evidence on the interplay between I4.0 technologies and servitization strategies of B2B SMEs, and has highlighted some performance implications. We see three main results emerging from the analysis that can be translated in research propositions to be further tested empirically, after enlarging the sample of firms involved.

First, our results suggest that the adoption of I4.0 technologies - and namely Internet of Things, Simulation, Cloud and Big data collection (and analytics) - was specifically addressed to increase the service offering of the firms. In particular, among interviewed companies (that were already offering a combination between products and services to their clients), we noticed that I4.0 technologies allowed many of them to provide new or additional services to their customers (e.g. remote maintenance, big data analytics on usage performance). Based on this, we propose the following research proposition:

Research proposition 1: Investments in I4.0 technologies - namely Internet of Things, Simulation, Cloud, Big Data and Analytics - enable the further infusion of services in B2B SMEs.

Based on our evidence, we could not conclude that the adoption of these technologies automatically and unavoidably lead to radical servitization. This can be related to a number of reasons and challenges connected with the implementation of a servitization strategy. Indeed, translating a product-based into a service-centered business model is not obstacle-free, as already discussed in the literature (e.g. Gebauer *et al.*, 2005). Moreover, all the companies we interviewed had already settled a service-centered growth strategy well before the adoption of I4.0 technologies. However, the cross-case analysis showed that through the adoption of specific I4.0 technologies (e.g. simulation offered in pre- and post-sales; IoT exploited to offer remote post-sales assistance), several companies were able to boost their service-infusion strategy towards a more radical servitization one by enhancing the existing one. Thus, I4.0 technologies acted as “enabling”. In other cases, I4.0 technologies empowered an already-in-place servitization strategy. Hence our second research proposition follows:

Research proposition 2: Investments in I4.0 technologies - namely Internet of Things, Simulation, Cloud, Big Data and Analytics - can enable B2B SMEs moving from a service infusion towards a servitization strategy or to empower the already existing servitization strategy.

Investments in I4.0 technologies were coupled since the beginning to specific business opportunities related to new or additional services that could be offered in the market. Sometimes, investing in I4.0 could be functional to reduce costs and to survive through competition, but it is not a sufficient condition to generate new streams of revenues related to these new services.

Companies that have simultaneously adopted a combination of I4.0 technologies in line with their servitization strategy were able to better exploit the value of the investment. Hence, I4.0 technologies can boost the effect that servitization strategies have on the performance of the firm, but they are not sufficient *per se* to generate better performance. They can bring positive returns in terms of e.g. customer loyalty and product positioning upgrading.

Based on this, we advance our last research proposition:

Research proposition 3: The combined adoption of I4.0 technologies - namely Internet of Things, Simulation, Cloud, Big Data and Analytics - leads to positive performance outcomes when coupled with a clear servitization strategy.

6. Conclusions

This study contributes to servitization literature, by providing a first empirical evidence of the interactions between I4.0 digital technologies and servitization, and their impact on firm performance in a B2B manufacturing context. Also, it contributes to management literature, by offering a first empirical evidence of Italian manufacturing SMEs that have adopted I4.0 technologies.

Sometimes, investments in new technologies are needed to remain competitive, but technologies *per se* do not automatically provide additional revenue streams or higher profitability. The cases we analyzed in this paper well highlight that the competitiveness of B2B firms in particularly challenging sectors (as the mechanical sector is) asks for strategic proactiveness, technological evolution, customer orientation. In this sense, investments in I4.0 technologies can boost current evolutionary process and current strategies, and even pave the way to new business strategies to be deployed, but do not offer sufficient conditions to increase the competitiveness of firms.

Servitization strategies, in turn, are resource-demanding and imply specific strategic, marketing and financial challenges: the organization must be prepared for such a change; revenue models must be revised and can be not easy to define; customers should be "educated" to new services, to understand the concrete benefits stemming from them and to be willing to pay a premium or an extra price for them. Last but not least, most services ask for new data and privacy management policies. All these things need financial resources. Hence, it is more likely for firms operating in B2B to adopt a step-by-step process in the transition from product-based business models to service-based ones, rather than radical moves. Such transition can be boosted by the adoption of specific I4.0 technologies, acting as accelerators, rather than enablers, of the transition. We refer, in particular, to IoT, Simulation, Cloud and Big Data collection (and analytics).

In relation to the impact of servitization strategies and I4.0 technologies on the firm performance, our results are not fully conclusive, but offer some interesting insights for further studies. Overall, the key of success seems to be the coherence between technology and strategy. In this landscape, though, there might be different nuances. Some companies can invest in a few selected technologies to infuse services in their offering, whereas other firms adopt a group of technologies coherently with a radical servitization strategy. Both situation can lead to positive impacts, but we might expect a superior effect in the case of higher levels of digital technologies and higher levels of servitization as underlined by Frank et al. (2019), as long as there is coherence between them. In this sense, more in-depth studies will be needed.

The managerial implications of our study are straightforward: investments in (selected) I4.0 technologies should be done with the aim of empowering existing (or adopting new, but specific) servitization strategies. Otherwise, returns will be unclear.

Our study comes with several limitations, mainly due to the limited number of cases we analyzed. Further studies involving larger samples will be needed to empirically test the strength of our research propositions.

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Open innovation and network dynamics. An analysis of openness of co-patenting collaborations in Italy

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Abstract

Objectives. *The aim of this work is to investigate the relational dynamics for innovation and in particular the impact of the innovation process openness on the innovation capacity of organizations.*

Methodology. *Through a multivariate linear regression, the work analyses the impact of the characteristics of openness of the organization's innovation process in the period 2004-2010 and how the breadth and depth of the openness influence the patents productivity in the following period (2011-2016).*

Findings. *The breadth of the open innovation process, measured by the number of external network ties that an organization realizes for the realization of patents, has a positive effect on patents productivity. The depth of the openness, that is the intensity of external network ties, has equally a positive influence on the innovative performance. But for both of them after a tipping point, the patent productivity tends to decrease underlining the costs and problems of open innovation practices.*

Research limits. *The study considers just patents collaborations in the city of Florence, therefore, it focuses just on codified innovations and on a single territorial case study.*

Practical implications. *The results underline the importance of the adoption of open innovation practices, but with several cautions. Just collaborate more with others does not foster the organizations' innovation productivity, but different shreds of evidence are reached.*

Originality of the study. *An original database has been elaborated containing all the information on patents realized in the metropolitan area of Florence from 2004 till 2016 and the Social Networks Analysis has been applied in order to identify the local innovation networks.*

Keywords: *Open innovation; networks, openness; breadth; depth; patents; Florence*

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1. Introduction

The concept of Open Innovation has attracted growing interest among innovation management and management scholars and has become one of the most debated topics (Vanhaverbeke *et al.*, 2014; Kovacs *et al.*, 2014).

Among the open innovation literature, several studies (Laursen and Salter, 2006; Chiang and Hung, 2010; Hwang and Lee 2010) have investigated the relationship between the firms degree of openness and its capacity to innovate by highlighting how the adoption of open innovation practices (Minshall and Mortara, 2011; Capone *et al.*, 2018) has a significant impact on the innovative capacity of organizations.

The aim of this work is to investigate the relational dynamics for innovation and in particular the impact of the innovation process openness on the innovation capacity of organizations. This work tries to investigate the following research questions: what is the role of openness in the dynamics of innovation networks? And in particular what is the impact of *breadth* and *depth* of the innovation process in the innovativeness of organizations?

The novelty of the work compared to the literature is that no analysis is carried out trying to investigate the link between the relational dynamics of organizations, analyzed through social network analysis and their open innovation strategy. There are numerous studies that underline the relevance of networks in OI (Dittrich and Duysters, 2007; Belussi and Orsi, 2016; Enkel, 2010; Martinez-Torres, 2014; Capone, 2016; among others), however, the link between these two streams of research is still undervalued. This work aims to contribute to this debate by investigating the opening up of innovation processes through firms' network dynamics.

Moreover, while there are some works that try to analyse open innovation dynamics in territorial innovation models like clusters and industrial district (Cooke, 2005; Simard and West, 2006), the differences of clustered firms in adopting open innovation practices is still under-investigated (Huang and Rice, 2013).

The work focuses on two determinants of the degree of openness of organizations: (i) the *external search breadth* which expresses the breadth of openness in terms of the number of external partners involved in the various innovative activities (Laursen and Salter, 2006). It can range from a close collaboration to a wider one as the number of external partners increases; (ii) the *external search depth*, understood as the depth of collaboration with every single source of external knowledge (Laursen and Salter, 2006). The collaborations are much deeper, the more interactions between partners intensify.

The empirical analysis is based on data collected using the Worldwide Patent Statistical Database PAT-STAT of the European Patent Office, containing information on patents developed in the main European countries.

In order to analyze the relational dynamics in a cluster or in a restricted geographical context, we decided to focus on the metropolitan area of Florence as a case study. This permits to focus on innovation activities developed in a restricted geographical context, where innovation and knowledge exchange is fostered by geographical proximity, trust and social capital (Porter, 1998; Tallman *et al.*, 2004). We constructed an *ad hoc* database that includes 3,189 patents made in the period 2004-2016.

An original database has been elaborated containing all the information on patents realized in the metropolitan area of Florence from 2004 till 2016 and the Social Networks Analysis has been applied in order to identify the local innovation networks. Through a multivariate linear regression, the work analyses the impact of the characteristics of openness of the organization's innovation process in the period 2004-2010 and how the *breadth* and *depth* of the openness influence the patents productivity in the following period (2011-2016).

The results underline the importance of the adoption of open innovation practices, but with several cautions. Just collaborate more with others does not foster the organizations' innovation productivity, but different shreds of evidence are reached if the characteristics of openness are analyzed. The breadth of the open innovation process, measured by the number of external network

ties that an organization forms for the realization of patents, has a positive effect on patents productivity. The depth of the openness, that is the intensity of external network ties, has equally a positive influence on the innovative performance. But for both of them after a tipping point, the patent productivity tends to decrease underlining the costs and problems of open innovation practices.

The remainder of the paper is structured as follows. Section 2 introduces the strand of research on open innovation and networks, focusing in particular on the role of breadth and depth of the innovation process. Section 3 describes the research design and data sources. Section 4 presents the co-patenting innovation networks in Florence, while section 5 focuses on the study of the relationships among actors through the application of ERGM. The final remarks synthesize the main results and implications.

2. Openness and networks

2.1 Open innovation, networks and cluster

Several authors focus on the process of opening up the innovation process outside of the firms' boundaries (Henkel, 2009; Herzok and Leker, 2010; Chiaroni *et al.*, 2011; Enkel and Bader, 2013). In fact, open innovation (OI) has also been analyzed in terms of the degree of openness of the firms' innovation process (Huzingh, 2011). Dahlander and Gann (2010) underline that there are several degrees of openness and that openness produces not only benefits but also costs (Laursen and Salter, 2006; 2014; Knudsen and Mortensen, 2011).

Huizing (2011) defines the openness of the innovation process on the basis of either the number and type of partners or the number and degree of the phases of the innovation process. Dahlander and Gann (2010) introduce a taxonomy of openness linked to the direction of this process (inbound and outbound) and to its nature (pecuniary or non-pecuniary).

Lazzarotti and Manzini (2014) analyze openness on the basis of both the partners' number and type, and the phases of the innovation process by using external sources. Trot and Hartman (2009) underline that the opening of innovation is not a standard process, but rather develops throughout a continuum of cases depending on the characteristics of the firms and the context where they operate.

In analyzing OI implementation, several authors have focused on the study of networks and network dynamics (Capone, 2016). Network dynamics are one of the possible ways of adopting an approach to open innovation, especially in outbound open innovation (Dahlander and Gann 2010). External networking is perhaps one of the most significant dimensions of outbound open innovation (Huizing, 2011), either due to the number of studies in this stream of research or the importance of the topic in the context of studies on innovation networks (Powell and Grodal, 2005; etc.).

The literature on innovation networks began to develop in the Nineties (Powell, 1990; Powell *et al.*, 1996) and although its origins precede the birth of Open Innovation, there are several contributions that have tried to integrate these two streams of research since its earliest stages (Chesbrough, 2003; Dittrich and Duysters, 2002; etc.).

However, in the international literature, there are few studies that fit in the intersection of these two streams of research. One of the first contributions in this regard is Dittrich and Duysters' (2007) study that states that innovation networks can be used to manage the process of technological change in the corporate environment by presenting a longitudinal case study of an innovation network during its transition from closed to open innovation.

Belussi and Orsi (2016) analyze the interconnections between networks, innovation and high-tech environment and underline that networks are a means of transition towards a more open approach to innovation, particularly in high technology sectors. Lee *et al.* (2010) study open innovation practices in small and medium firms, confirming the potential of adopting of open innovation practices in SMEs and indicating networking as one effective way of facilitating

innovation among small firms. Wincent *et al.* (2009) underline the role of boards in strategic small firm networks that employ them to effectively manage joint research-and-development activities.

Enkel (2010) investigates the role of networks in performance and profitability. She studies the personal and organizational attributes that are required to profit from open innovation. Moreover, she underlines that the attribute of openness and the possibility to equally contribute to influencing the value that individuals receive from open innovation networks.

Finally, Brunswicker and Van de Vrande (2014) explain that a key area in research on open innovation in small firms consists of the importance of different kinds of networks when SMEs engage in open innovation. The two authors underline that as the locus of innovation regularly resides

at the network level, open innovation in SMEs is naturally quite specific and different from large firms and it is necessary to explore the unique challenges of leveraging and managing open innovation in SMEs.

In addition, networking in open innovation does not only bring advantages. Jarvenpaa and Wernick (2011) analyze the difficulties of developing networks for open innovation, pointing out that networks in the context of open innovation produce more obstacles than other types of networks.

Martinez-Torres (2014) investigates open innovation communities through social network analysis and interpersonal networks of community members. Results underline how collective intelligence evaluation schemes can be useful to identify users that post ideas that are potentially applicable to the organization. In this same context, Fichter (2009) explores the role of promoters and networks of promoters in Open Innovation communities, underlining the relevance of interpersonal networks for innovation beyond the firm's boundaries.

Finally, there is recently also an interesting hype on the role of geographical proximity in fostering innovation (Boschma, 2005) and in particular open innovation practices. Cooke (2005) has pointed out, open innovation may partially explain the competitiveness of regional innovation systems, and Vanhaverbeke (2006) has underlined that firms in regional clusters tend more to employ open innovation practices. Huang and Rice (2010) analyze the role of clusters in boosting open innovation practices in Europe. They find that close geographical proximity tends to increase firm-university linkages, enhance inter-firm explicit and tacit knowledge flows and lead to comparatively less reliance on internal R&D. The cluster benefits of reduced transaction costs and increased trust and reciprocity tend to facilitate the adoption of open innovation practices. Di Minin and Rossi (2016) describe what makes clusters particularly suitable as vehicles of open innovation. Their analysis focus on three distinctive attributes such as (i) access to finance, (ii) cross specialization of assets as internal learning and specialization produced within firms, that can contribute to more innovation solution and (iii) local trust, a key in guaranteeing the continuous exchange of knowledge and boost open collaborations. Giusti *et al.*, (2018) analyses the role of open innovation networks in an Italian high tech cluster. They find the interesting result on how knowledge is locally embedded and exchanged in innovation networks and how knowledge leaks occur.

Vanhaverbeke, Chesbrough and West (2014) stress that it will be important to analyze the role of geographical concentrations in the territory such as clusters and districts to understand if they can be a driver to further promote open innovation, particularly for the dissemination of knowledge and for the role of local networks. Simard and West (2006) underline how the benefits of OI can be better achieved in clusters of companies, research centers, universities, and institutions, which constitute a favorable environment for the exchange of knowledge and better collaboration between companies. Finally, the two authors highlight the potential of integrating social theories and Social Network Analysis with the analysis of collaborative processes in OI.

2.2 Openness and innovation: breadth and depth

Among the first empirical studies in the field of open search strategies, measured in terms of *breadth* and *depth*, Laursen and Salter (2006) investigate the impact of the breadth and depth of relationships with external sources of knowledge on the performance of manufacturing companies in Great Britain. The study shows that, within a certain limit (tipping point), breadth and depth are positively correlated with innovative performance. Beyond a tipping point limit, they generate a negative impact on the innovative performance of the firm.

This study represents the starting point from which many other contributions have been developed regarding the openness of companies. Chiang and Hung (2010) describe the impact of breadth and depth, respectively on incremental innovations and radical innovations, reaching an opposite result compared to Laursen and Salter (2006). They demonstrate that the breadth and depth of the opening are positively correlated with innovation performances.

More recent contributions have extended the analysis of Laursen and Salter (2006) by introducing new elements that can be influenced by breadth and depth. Hwang and Lee (2010) analyze the relationship between breadth and depth of openness, innovative performance, and productivity. The results show that, beyond a certain level, the breadth of the relationships has a positive impact on productivity (U relation), while the depth of the relationships tends to have an opposite trend (U-inversed relation), so an excessive level of depth generates a reduction in productivity.

Chen *et al.* (2011) include in the analysis, in addition to breadth and depth variables, the concept of the orientation of external search strategies, as the type of partner with which collaborations are established and how this affects the ability to innovate companies. The authors highlight that the breadth and depth of the relationships positively influence the innovative performances and that the identity of the partners also determines a better result in terms of innovation.

Martinez *et al.* (2014) explore the role of firms internal organizational variables and external context variables as the two main forces that determine the level of openness of companies. The authors also point out that both breadth and depth have a positive impact on innovative performances.

Finally, Ferreras-Méndez *et al.* (2015) analyze the link between opening strategies and absorptive capacity with both innovative and business performance. The results show that there is no link between depth, breadth and innovation and business performance. The intensity of the relationships is positively correlated with the level of absorptive capacity, which, in turn, positively influences the innovative and business performance.

In conclusion, all the contributions regarding breadth and depth, with the exception of Ferreras-Méndez (2015), show a positive influence of these variables on the innovative performance of firms. Therefore, pursuing openness strategies may determine a higher performance and a competitive advantage for companies that innovate. Having more links increases the likelihood of obtaining useful external knowledge that can be combined with the internal knowledge of the company to produce innovation.

However, some studies (Laursen and Salter, 2006; Hwang and Lee, 2010; Chen *et al.*, 2011) show some limits to the value of external links for innovation.

Research is expensive, and it is expensive also to realize appropriate contractual arrangements for many external channels and to maintain these links over time. For companies, therefore, the openness represents an opportunity to be grasped, but, in order to be profitable, the breadth and depth of the relationships to be established must be adequately balanced taking into account the organization's capabilities.

Table 1 summarises the main empirical studies on the impact of breadth and depth of openness of the innovation process.

Tab 1: The main studies on the breadth and depth of openness and performance

Authors	Sample	Results
Laursen e Salter (2006)	2.707 manufacturing firms in U.K.	Beyond a certain limit, breadth and depth have a negative impact on the innovative performance (U-inverse relation)
Chiang e Hung (2010)	800 firms in Taiwan (members of TEEMA)	Breadth and depth are positively correlated to the respective forms of innovation
Hwang e Lee (2010)	123 ITC Korean firms	Breadth is not related to incremental innovations, it has a U-inversed correlation with radical ones, U-shaped with productivity. Depth is not related to innovative performance, it has a U-inversed relation with productivity.
Chen J., Chen Y. e Vanhaverbeke (2011)	209 Chinese firms that have a national or regional R&D center in China's Zhejiang province	In STI industries, U-inverse relationship between breadth and performance, positive between depth and performance. In DUI industries, breadth and depth are positively correlated with innovative performance. The type of partner chosen is different in the two industries and has a positive impact on innovative performance.
Love, Roper e Vahter (2014)	Manufacturing Irish and north Ireland firms. Longitudinal analysis: 1994-2008	Openness represents a double advantage: openness increases innovative performance in the current period and also provides the basis for learning effects, which increase the innovative performance of future openness.
Martinez, Lazzarotti, Manzini e Garcìa (2014)	284 firms in Food & Beverage: 108 in UK, 92 in Spain, 84 in Italy	Internal and external variables influence the level of openness; a positive correlation between breadth, depth, and innovative performance
Ferreras-Méndez, Newell, Fernàndez-Mesa e Alegre (2015)	102 Spanish firms in biotech	No correlation between breadth, depth and innovation and business performance. The depth is positively correlated to the absorptive capacity (AC). AC positively influences both innovative and business performance.

Source: our elaborations

3. Research design

In order to analyze the relational dynamics in a cluster or in a restricted geographical context, we decided to focus on the metropolitan area of Florence as a case study. This permits to focus on innovation activities developed in a restricted geographical context, where innovation and knowledge exchange is fostered by geographical proximity, trust and social capital (Porter, 1998; Tallman *et al.*, 2004).

The empirical analysis is based on data collected using the Worldwide Patent Statistical Database PAT-STAT of the European Patent Office, containing information on patents developed in the main European countries.

From the PATSTAT database, all the patents realized in Italy in the period available (2004-2016) have been collected (about 68,000 patents). After that, a selection has been made creating an ad hoc database that includes 3,189 patents involving at least one inventor in the metropolitan area of Florence over a period of more than ten years 2004-2016. Patents developed exclusively by inventors who do not belong to the Province of Florence have been excluded from the analysis.

Each patent was then analyzed by carrying out a handmade disambiguation process both on the inventor and on the applicant of the patent. In fact, often both the inventor and the applicant are transcribed incorrectly and with heterogeneous information. Furthermore, the PATSTAT database is not disambiguated and therefore univocally inventors and applicants are not identified[1].

The final database is composed of 538 applicants (firms, inventors, research centers and universities) who realized 3,189 patents in the period.

Furthermore, in order to perform the analysis of the organizations' relational dynamics, the database was organized in a functional way to the application of Social Network Analysis (Scott, 2011) with the aim of focusing on inter-organizational relationships deriving from collaborations for the realization of the patents.

[1] See for instance Balconi *et al.*, (2004) or the debate in Ventura *et al.*, (2015).

The choice of representing the network of the applicants rather than of the inventors is due to the interest of investigating whether the organizations realized more patents within their boundaries, according to the closed innovation paradigm or in collaboration with other companies, universities, research centers or external inventors, following the paradigm of Open Innovation (Chesbrough, 2006).

The data for the relational analysis were elaborated starting from an "Applicant x Inventor" matrix that configures a bipartite (two-mode) network in which the lines indicate the subjects that realized the patent and the columns the inventors. The uni-partite (one-mode) network was then obtained from the bimodal network with the transformation of the "Applicant x Inventor" matrix into the "Applicant x Applicant" co-membership network in which the intersections between actors indicate the number of patents to which a couple of actors participate together.

At this point, it was possible to use the UCINET software for the graphic representation of the innovation networks with graphs (Fig. 2 and 3), in particular, the network of applicants who have at least one co-patenting collaborations.

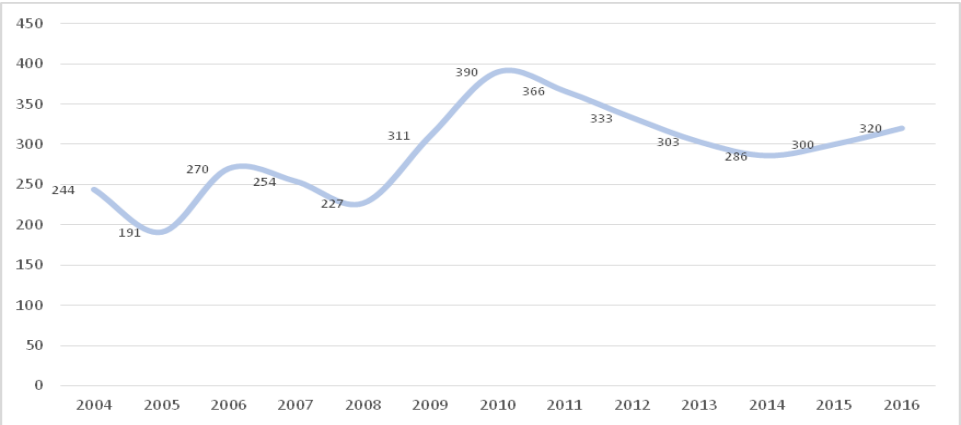
Finally, through a multivariate linear regression, we analyze the impact of the characteristics of openness of the organization's innovation process in the period 2004-2010 and how the *breadth* and *depth* of the openness influence the patents productivity in the following period (2011-2016). The two time periods have been chosen in order to avoid problems of causal ambiguity. Collinearity diagnostics have been tested in order to avoid problems of multicollinearity.

4. The co-patenting invention networks in Florence

The final database collects 3,189 patents that have involved the participation of at least one inventor of the Province of Florence for the period 2004-2016. They are realized by 538 applicants like firms, universities, research centers or individual inventors. Florence is the province that realized more patents in the Tuscany region in the period and it is one of the provinces in Italy that realized more patents in the period after the big cities like Milan, Bologne, Rome, etc. So it can be a perfect case study to analyze co-patenting activities in a restricted geographical context as a case study.

The first information of particular interest concerns the trend of patents over the years (Figure 1) which shows how in the year 2010 the patents reached their maximum number but then decreased in the following years. Values fluctuate around the mean (286) in the period. Unfortunately, it was not possible to go beyond 2016 as a year of analysis, because the number of patents is identified on the basis of the priority date, i.e. the date on which the patent is requested by the applicant, from which a period of 24 months may occur before the patent becomes effective, therefore only partial data are present in the last two years (2017-2018).

Fig. 1: The evolution of patents in Florence. 2004-2016



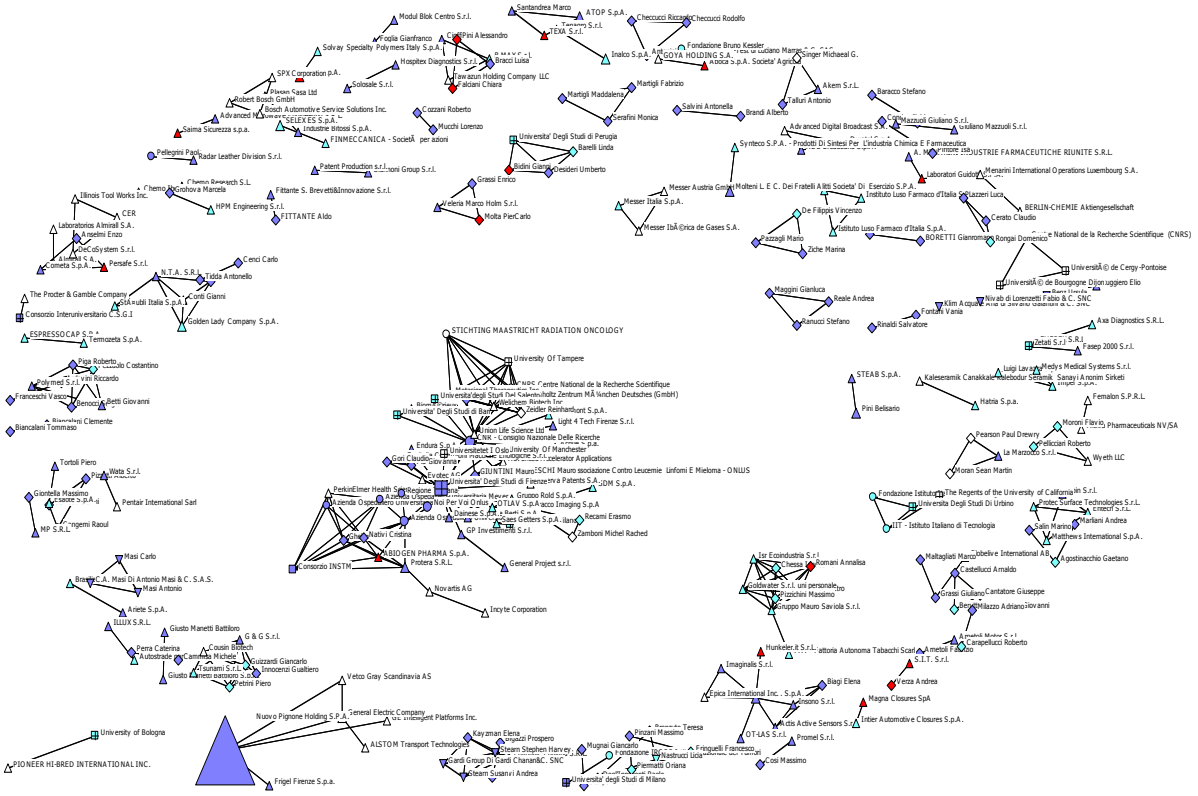
Source: our elaboration.

We analyze here the invention networks in Florence through the graphical representation of the overall network of applicants for the realization of the patents in the period 2004-2016.

The study of the relationships between firms, universities, research center, and other organizations has been developed according to the methodology of Social Network Analysis (Scott, 2011) in order to evaluate the openness of the innovative process of the various actors, establishing whether, and to what extent, they have adopted an Open Innovation approach. innovation. In fact, it is possible to analyze the structure of networks, how relationships are constructed, how deep they are and the role played by each subject within individual networks.

Figure 2 shows the network of the applicants with at least one co-patenting activity, that is the organizations collaborate for the realization of at least *one* patent. The nodes represent the different organizations, while the thickness of the ties indicates the number of patents co-produced by two organizations, which measures the intensity of the relationship. The size of the nodes is related to the number of patents made by each individual organizations.

Fig. 2: The invention networks for co-patenting in Florence. 2004-2016



Source: our elaboration. Legend: shape for typology: Up-Triangle: limited liability company, Down triangle: partnership / individual firm, diamond: individual inventor, Crossed box: University, Box: Consortium, Circle: others. Colors for localization: Purple: Florence, Azure: Italy, Red: Tuscany; Green: Europe.

For better visualization of the invention network, Figure 3 has been elaborated in which the collaborations between a pair of organizations who have more than three co-patents are shown, to highlight the non-occasional and more frequent collaborations.

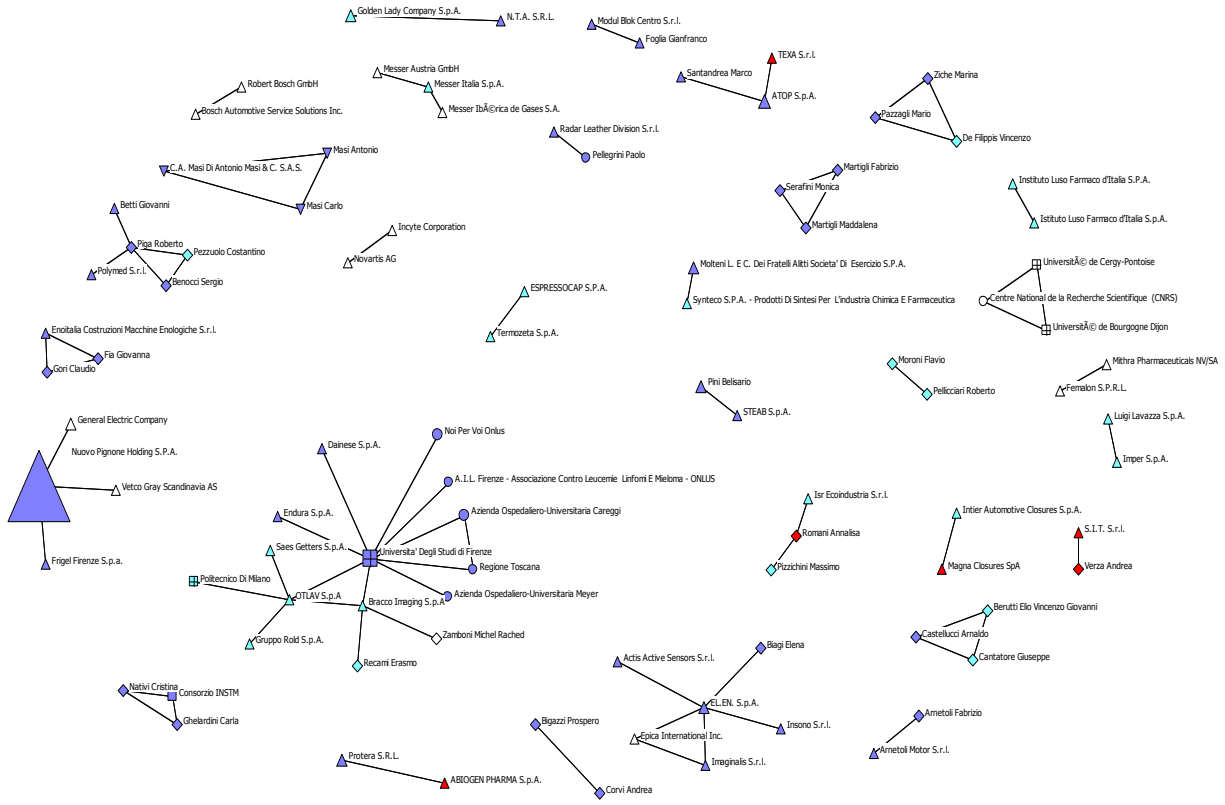
From Figures 2 and 3 it is possible to develop some reflections. The most interesting result is the emergence of several sub-networks, of which the most structured is that of the University of Florence (in the center of Figure 2). Also worthy of mention is the presence of the open network of some large companies (El. En for example) which is related to the development of several patents (78) above all with other companies located in the Province of Florence.

The various networks refer above all to the metropolitan area of Florence (purple nodes), involving mainly firms, but also individual inventors, non-profit organizations, research centers, etc. The European players (green nodes) have few connections, to be noted those with General Electric -

Nuovo Pignone which relies mainly on actors located in Europe and develops innovation mainly within it, according to the closed innovation paradigm. It is, in fact, the biggest node on the figure with around 500 patens realized within the boundaries of the firm.

Figure 3 presents a focus on the most important patents collaborations with at least a co-participation to 3 realized patents.

Fig. 3: The invention networks for co-patenting in Florence. 2004-2016



Source: our elaboration. Legend: See figure 2.

5. An analysis of openness of the invention network in Florence

5.1 Operationalization of the variables

The purpose of this section is to analyze the impact of the openness of the innovative process of the different organization participating in the invention networks. For the purpose of regression analysis, different types of variables were used:

- the Openness of the organization invention process, which measures the degree of openness of the innovative process;
- the breadth and depth of the openness, which respectively indicate the breadth and depth of the opening of the invention process in terms of the number of external partners with which an organization collaborate for the realization of patents and depth of relationships maintained with each individual partner;
- the centrality-betweenness, a variable of Social Network Analysis, which is connected to the ability of an organization to act as an intermediary between other subjects. It expresses the potential of a network node in the control of communication: the greater the centrality-betweenness the greater the role of the actor's connector acting as a broker to unite and relate other unrelated nodes;

- then some dummy control variables were added concerning the location of companies (Florence, Tuscany, Italy, Europe) and the type of actor (inventors, limited liability companies, partnerships, universities) with the intent of verifying the possible influence they may have on the ability to innovate.

Openness is measured as the share of patents realized through collaboration with external actors and has been calculated as the ratio between the number of patents made with external sources and the total number of patents developed by each actor.

Regarding *breadth* and *depth*, Laursen and Salter (2006), measuring the openness of the innovative process of companies, have defined breadth as the breadth of external research in terms of variety of partners and innovative sources and depth measured by the intensity of the collaborations with that external sources. All other works follow this approach (Hwang and Lee, 2010; Chen *et al.*, 2011).

In the present study, we follow a social network analysis perspective and we calculated the breadth and the depth on the basis of the structure of the invention networks (Capone, 2016). The breadth variable was calculated as the sum of the number of external actors with which patents are realized, i.e. the number of co-patenting organizations. While the variable depth has been calculated as the average of the number of co-patents developed with the external co-patenting organization. For example, if a subject realizes 20 co-patents with 5 different partners, he presents a depth value of 4 and a breath of 5. Table 2 shows the variables built for analysis.

Tab. 2: Operationalization of the variables

Variables		**Operationalization**
Dependent variables		Patents realized in the 2011-2016
Independent variables (2004-2010)	Openness of the innovative process	
	Openness	Share of patents realized with other
	Breadth	Number of external organization with whom realized a co-patenting
	Depth	Average number or relationships with each external co-patenting organization
	Broker between organisations	Betweenness
Dummy control variables	Localization	Florence, Tuscany, Italy, Abroad
	Typology	Limited liability firm, partnership, university, research center, inventor

Source: our elaboration.

5.2 Analysis

A multivariate linear regression analysis was conducted with the aim of verifying how the openness of the organizations' innovative process in the period 2004-2010 may have influenced the ability to innovate, in terms of the number of realised patents, of the actors in the following 2011-2016.

Table 2 contains the results of the OLS linear regression analysis. The analysis is based on 386 observations, which constitute the organisations that have realised a patent in the two periods (2004-2010 and 2011-2016).

Five different models have been elaborated. The first one includes only the variables of the opening of the innovative process (openness, breadth and depth). In the second model, the betwenness variable related to the relational behavior of the actors is also tested. In the third one, dummy variables related to the location (Florence, Tuscany, Italy, abroad) have been included, while in the fourth one also the dummy variables of the typology of the actor involved (corporations, partnerships, universities, inventors) have been added. The last model analyses also the squared variables of the openness of the innovative process ($breadth^2$ and $depth^2$) in order to evaluate any U-shaped trends of the degree of openness on the ability to innovate, as highlighted in the literature review.

The results of the model are shown in Table 3. The R2 of the various models is increasing and confirms the improvement of the estimation in the final model. Pearson's correlation analysis between the models' variables shows that these are not excessively correlated with each other so as to avoid problems of collinearity in the models. Table 3 shows the average values of the VIF for the collinearity test.[2]

The openness of the actors is significant and negative, indicating that a higher degree of openness negatively affects the ability to realize patents. This is an could be seen as an unexpected result, but it just highlights that a generic openness does not necessarily foster the inventive productivity of organisations. Just develop relationships with others does not help to be more innovative. Of course, this is also related to the internal capacity of firms to develop innovations.

This results, however, could be also a specificity of the metropolitan area of Florence, where actors tend to develop innovations mainly in accordance with the closed innovation paradigm. This may partly be due to the fact that companies that develop more patents are large companies and develop patents within their borders.

However, different results are achieved if we investigate other the characteristics of the openness of the organisations innovation process. The breadth is significant and positively influences the propensity to innovate. This indicates that developing relationships with a large number of external actors increase the innovative capacity of companies.

Also, the depth is significant and positive, underlining that developing deep and lasting relationships with the external partners allows to realize a higher number of innovations. This aspect can also create trust among local organisations and therefore improve local collaborations and therefore the innovative performance of the organisations.

Therefore, if a "generic" openness does not appear to be a positive determinant for the innovative capacity of the organizations, the depth and breadth of the openness instead positively influence the realisation of patents. It is also important to underline that a generic openness shows only a propensity to develop patents with others and therefore does not take into account the internal resources and capability needed to innovate (Cohen and Levinthal, 1990).

Regarding the other variables, the betweenness is significant and negatively affects the ability to produce patents, so it does not seem to be confirmation that playing the role of connector between subjects allows an actor to be more innovative.

The dummies of the location and typology of organisations are both not significant in the models. As a result, there is no evidence regarding the relationship between the geographical location of the actors and their ability to innovate. So even if we analysed a sample that gravitates in the metropolitan area of Florence, collaborations are also developed with external actors and pair only with local actors does not seem to make a difference. The same consideration can be made for the typology of organisations, which is not significant in the various models.

Model 5 is the final model and considers also the squared variables of openness. The breadth variable positively influences the patent productivity, as before, however the breadth^2 turns out to be (significant and) negative. This result implies that the breadth of the openness, measured by the number of external co-applicants with which every single subject creates patents, beyond a certain limit negatively affects the ability to innovate.

From Figure 4a it is possible to notice that the breadth is not linearly related to the patents productivity, but it assumes a U-inversed curvilinear pattern. There is a so called "tipping point" beyond which the number of organisations with which an actor collaborates negatively affects the capacity to innovate. This limit is identified in 6 patents collaborations for the analyzed case (in the period 2004-2011). Increasing the number of partners improves the innovative performance of organisations until reaching an optimal number of collaborations, after which the opening becomes counterproductive.

Also with regard to depth, similar conclusions have been reached. The results of the analysis indicate a positive and significant coefficient, while the depth^2 results to be negative and significant.

[2] Values above 10 indicate multi-collinearity problems. It is observed that for the analysed variables, the VIF values are always below the threshold value of 10, avoiding the presence of multicollinearity.

As the breadth, the intensity of relationships with external sources knowledge also takes on a U-inverse relation to the innovation productivity. The tipping point for the intensity of the relationships is 6, beyond which the returns in terms of inventions decrease (Fig. 4b). As a result, an organisation who has had less than 6 relationships with a co-applicant in the period 2004-2010, has developed higher patent productivity in the period 2011-2016.

In conclusion, the results of the analysis show that, within a certain limit, breadth and depth are positively correlated with the patent productivity of organisations. Beyond a certain level, they generate a negative impact on the innovative performance of the actors.

An estimation was also developed for the years 2010-2016 and presents the same results achieved with the previous analysis.

Tab. 3: OLS estimations

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Openness	-0. 427 *** (8.467)	-0.531 *** (9.799)	-0.532 *** (9.946)	-0.544 *** (10.692)	-0.970*** (0.674)
Breadth	0.291 *** (1.205)	0.421 *** (1.580)	0.429 *** (1.598)	0.449 *** (1.651)	1.248*** (5.549)
Depth	0.268 *** (1.206)	0.298 *** (1.235)	0.296 *** (1.253)	0.296 *** (1.268)	0.727*** (4.570)
Breadt^2					-0.746*** (-4.445)
Depth^2					-0.408*** (-3.035)
Betweenness		-0.134 * (0.084)	-0.138 * (0.084)	-0.148 * (0.087)	
Tuscany			-0.021 (5.810)	-0.26 (5.894)	
Italy			-0.001 (4.013)	-0.007 (4.170)	
Europe			0.032 (4.292)	-0.038 (4.554)	
University				-0.06 (12.609)	
Limited liability firms				0.121 (8.594)	
Partnership				0.042 (10.767)	
Inventor				0.108 (8.883)	
DF	3	4	7	11	5
VIF Mean	2.25	2.82	2.11	3.15	9.81
R^2	0.069	0.076	0.070	0.062	0.142
Obs.	386	386	386	386	386

Legend: standard errors in parenthesis. Significance: ***: 0,001; **: 0,01; *: 0,05.

Fig. 4: Breadth, depth and inventions productivity

Figure 4a: Breadth and inventions

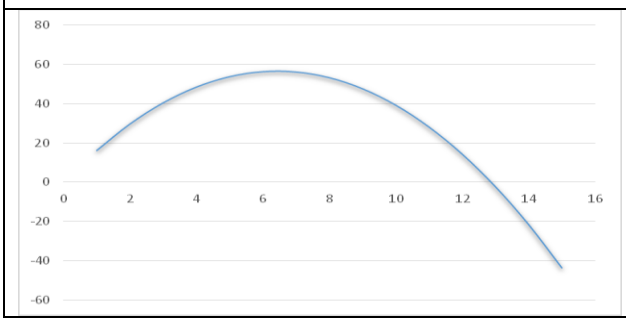
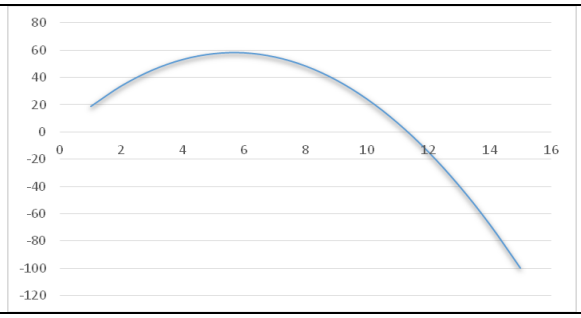


Figure 4b: Depth and inventions



Source: Our elaborations.

6. Conclusions

The results of the analysis allow us to respond positively to the advanced hypotheses that the openness of the innovation process of organizations through co-patenting activities would have an impact on their innovation capacity.

Specifically, the study determined quite similar shreds of evidence compared to those of Laursen and Salter (2006). The authors, who have examined the effects of the opening on the performance of manufacturing firms in Great Britain, have in fact shown that the external search breadth and the external search depth assume a U-inverse trend compared to the innovative performance. In particular, within a certain limit, breadth and depth are positively correlated with innovative performance. Beyond a certain limit, they generate a negative impact on the innovative performance of the company.

The present study confirmed the same impact on the firms' innovation capacity over time of the breadth and depth of the opening of the innovative process. In particular, a tipping point was identified for the breadth variable of 6, as well as for the depth.

The results achieved coincide also with those obtained by Love *et al.* (2014). In the longitudinal analysis (1994-2008) conducted on a sample of Irish and Northern Irish manufacturing companies, the authors measured the effects of learning deriving from the outward opening on innovative performances. The results to which Love *et al.* (2014) suggest a link between the concept of absorptive capacity (Cohen and Levinthal, 1990) and the future innovative performance: managers accumulate experience from the process of selecting and/or managing multiple relationships in a single period and are able to apply what has been learned in the following periods. The opening of the innovative process can represent a double advantage for companies: openness increases the innovative performance in the current period and also provides the basis for learning effects, which increase the innovative performances deriving from future openness.

In the empirical analysis carried out, the firms that, within the limits described above, have adopted an open approach to innovation, have also improved their innovative performances and this can be explained in part by a greater level of absorptive capacity.

The research also presents some limitations. First of all, the number of patents created by the organization has been used as a proxy for the innovative performance of companies. The patents, however, identify only the codified innovation and not all the innovation outputs, both formal and informal, of the companies (R&D projects, research collaborations, etc.); The analysis carried out was then limited only to some aspects of the opening of the innovation process, therefore it would be interesting and useful to extend the research in order to have a picture as comprehensive as possible of the effects of the openness of firms innovation processes. Secondly, the PAT-STAT database suffers from a limitation due to the fact that it does not uniquely recognize individual inventors, making it impossible to uniquely identify inventors. Hence we follow the choice to analyze only the applicants' network rather than the inventors' network.

Thirdly, the research has focused on a narrow territorial context, that of the metropolitan area of Florence. In this regard, future research could expand the empirical analysis to a wider level such as the whole of Italy. Etc.

An interesting point for further research could be to include in the analysis data that more accurately approximate the innovative capacity of firms, for example, the share of turnover deriving from new products or R&D expenses, etc. This would permit to establish whether openness is also related to the same internal characteristics of the firms and how this is related to their relational behaviors.

Notwithstanding the limits of the research, this work is interesting as it has proved that relational activities affect also the openness of innovation process and influence the capacity of firms to innovate. Managers should then evaluate with the attention their environment and firms relational capabilities in order to maximize their performance and reduce costs and waste.

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