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Inside-out: the forgotten side of ICT-enabled Open Innovation

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Inside-out: the forgotten side of ICT-enabled Open Innovation

Purpose. The role of Information and Communication Technologies (ICTs) in enabling connectivity and collaboration among actors is neglected when dealing with outbound Open Innovation (OI). Moreover, the outbound OI process is not currently defined in a univocal way. Thus, this paper aims at outlining the outbound OI phases and at exploring the role and capabilities of ICTs in supporting it.

Design/methodology/approach. Through a literature review, we specified the outbound OI process phases. Hence, we leveraged the similarities between the Knowledge Management process phases and the outbound OI phases for developing a conceptual framework that matches the outbound OI phases with acknowledged categories of ICT tools.

Findings. Through a process-view, we outlined the outbound OI as a three-phase process. We structured a matrix-shaped framework in which the columns represent the three outbound OI process phases, while the rows are three ICT categories that may be suitable for supporting the outbound OI process.

Practical implications. The framework is designed to guide a deep understanding of how ICTs may support specific phases of the outbound OI process. Also, it may be useful for software developers interested in a preliminary design of an ICT platform for outbound OI.

Originality/value. The conceptual framework proposal: (I) specifies a detailed, process-oriented definition of the outbound OI; (II) allows the identification of the main ICT categories supporting the phases of the outbound OI process; (III) provides guidance for further exploration about the role of ICT in outbound OI.

Keywords. Outbound Open Innovation, Process view, ICT tools, Conceptual Framework

Article classification. Research Paper.

Introduction

The exploitation of digital technologies in knowledge transfer from and to external partners is a nontrivial management issue (Awazu *et al.*, 2009; Cui *et al.*, 2015; Stefanini *et al.*, 2018). Indeed, digital technologies, specifically those Information and Communication Technologies (ICTs) that are part of the digital infrastructure (Nambisan, 2017), can support firms' Open Innovation (OI), since they enable generation, sharing, retrieval, and storage of data, information, or knowledge that could dramatically impact how organizations manage their boundaries (Bogers *et al.*, 2017).

More specifically, a number of ICT tools supporting OI is now available and the literature has investigated their role in supporting OI from different perspectives (Adamides and Karacapilidis, 2017). Examples of ICT tools supporting OI are: online innovation tools (Bengtsson and Ryzhkova, 2013) aimed at involving the users, who have been recognized as one of the most valuable external knowledge sources for innovation (Von Hippel, 2006), into the innovation process; social media, which enable individuals to generate and share content (Bugshan, 2015); technologies for data mining, simulation, prototyping and visual representation supporting OI in new product development (Dodgson *et al.*, 2006); platforms for connecting innovators, for offering services such as consulting or technology scouting, and for collecting ideas from a large and dispersed "crowd" to solve problems and to gather ideas for new products and services (Di Gangi and Wasko, 2009; Leimeister *et al.*, 2009; Majchrzak and Malhotra, 2016). Crowdsourcing platforms can be distinguished according to the way they are managed. There are platforms, such as for instance Innocentive, NineSigma, Yet2come.com, and Atizo, that work as knowledge brokers between firms aiming at broadcasting innovation challenges and external contributors posting solutions to those challenges. There are also platforms managed by firms seeking to fuel their own innovation pipeline, *e.g.* Idea Storms by Dell and Global Innovation Jams by IBM (Frey *et al.*, 2011).

The above examples, on the one hand, emphasize that ICT tools are critical in assisting knowledge flows that occur during OI processes and have helped to support the shift towards more open innovation practices (Dodgson *et al.*, 2006), but, on the other, highlight two main weaknesses

affecting the OI-related ICT literature. Firstly, the scientific debate has almost totally concentrated on the ICT tools supporting the inbound OI process. Hence, the outbound OI process has scarcely been investigated, and the identification of its phases has almost been neglected. Secondly, the literature has dug into specific ICT tools supporting specific phases or even specific activities of the OI process. Thus, the scientific effort has offered a fragmented overview of the type of support ICT tools may provide. This means that, so far, the current scientific debate does not provide a thorough perspective that analyses the interconnections between the ICT tools as far as the OI process unfolds during its phases.

All in all, the literature lacks a framework that, on one side, analyses to the whole outbound OI process and, on the other, offers a thorough view of the support that ICT tools can provide to the OI process, while assisting the corresponding OI knowledge flows (Dodgson *et al*., 2006). This is felt in the scientific community as a compelling gap that should feed the next research agenda on OI (Bogers *et al.*, 2017). Nevertheless, evidence from the field also shows that firms are more and more interested in using ICT to support outbound OI processes.

Accordingly, this research aims at exploring the role and the capabilities of ICT in backing the outbound OI process up, as a first step in providing guidance for the design of an ICT-based platform for outbound OI.

Thus, on the premise that OI "*occurs where knowledge transfer and knowledge flow [take place] beyond the boundaries of a single organization*" (Secundo *et al*., 2018, p. 151; Chesbrough, 2003) and also that knowledge flows towards and from the external environment have to be managed also internally, we built a conceptual framework matching the OI process phases with categories of ICT tool supporting Knowledge Management (KM). While leveraging the extant literature in OI, ICT, and KM areas, our objectives are:

1. To define the outbound OI process and its activities, whose formulation is neither univocal nor complete in the literature;

2. To leverage the extant literature for figuring out which ICT tools may support which outbound OI activities, according to the framework;

3. To formalize the outbound OI activities and ICT dimensions/tools within the organized framework.

The next section briefly outlines a theoretical background about the process-view of the OI process and the involvement of ICTs.

Theoretical background

One of the most promising perspectives proposed in the extant literature interprets OI as a macro-process (West and Bogers, 2013; Slowiski and Sagal, 2010). This perspective has great potential both for theory and practice, as it provides managers/professionals with tangible guidance to understand OI process phases and activities and to set-up controls and related management actions appropriately (Tavakoli *et al.*, 2017). In such a macro-process view, three key processes (also modes) can be distinguished (Enkel *et al.*, 2009; Gassmann and Enkel, 2004): the outside-in process, also referred to as 'inbound' process, which consists in accessing the technical and scientific knowledge and competence from external sources to integrate them internally; the inside-out process, also referred to as 'outbound' process, which involves looking for partners with a business model better suited to commercialize a technology (Chiaroni *et al.*, 2009); and the coupled process, consisting of a balance between the two previous processes.

The outbound OI process suffers from a dearth of attention by extant literature (Lichtenthaler, 2011; Gassman *et al.*, 2010) and is characterized by complex, sometimes low-structured tasks and decisions that may deeply benefit from the ICT support. In fact, ICT can foster and support process coordination, communication, and the related tasks that are essential in OI, such as communication among different actors, cooperation, knowledge creation and sharing/transfer. Thus, we contend that, similarly to many other organizational processes, also the outbound OI process may greatly benefit from the support given by a dedicated ICT platform that, while being capable of integrating all the

outbound OI activities and phases and of facilitating the information and control flow, may avoid the fragmentation of the different process phases.

On this point, the empirical evidence and the scientific debate move forward with different speed, being undoubtedly the first forward of the second. On the one hand, the empirical evidence shows that OI platforms have exponentially grown during the last years (*e.g.* Innocentive, NineSigma, Yet2.com concern with inbound OI). Yet, existing platforms support only specific OI phases or sub-processes, but not the process in its own entirety. On the other hand, the scientific debate, while recognizing that ICTs can enable the whole inbound process (Awazu *et al.*, 2009) and analysing the existing platforms (for a review see Tavakoli *et al.*, 2017), has rather disregarded the way firms can support the whole OI outbound process by means of ICTs (Cui *et al.*, 2015). Also, to our best knowledge, literature does not offer any contribution regarding the systematic investigation on how ICT can support the outbound OI process, which is propaedeutic to any preliminary, systematic design (specifically a conceptual design) of such an ICT platform.

Research design

Firstly, in a preliminary step, we carefully reviewed the OI literature to identify the process phases and tasks that characterize the outbound OI processes. To ensure an exhaustive literature review, we analyzed articles selected from the top 50 most-cited technology and innovation management journals as reported by Linton and Thongpapanl (2004). The review was restricted to the time window from 2003 to 2018, since the OI concept was introduced by Chesbrough in 2003, and we exploited the following search string: "outbound Open Innovation" OR "external Open Innovation" OR "Inside-out" OR "External technology transfer". By leveraging the dual relationship that may occur between the outside-in and inside-out OI process flows, we considered the inbound OI phases as a reference framework for the review. In particular, we relied on the inbound OI process formalization by Aloini *et al.* (2017), which is structured in two phases and three sub-phases:

- *Obtaining phase*: identifying and sourcing innovations through two sub-phases, *i.e.* "technology scouting" and "external knowledge sourcing";
- *Integrating phases*: "collaboration establishment", *i.e.* assessment and selection of external knowledge sources.

The three sub-phases were used as logical areas which the evidences from the review were assigned to. Hence, the labels of the phases were revised according to the review's findings. The review led to the identification of three sub-phases – exploration of markets and technologies, assessment of technological portfolio, and external transfer of technologies – that outline the outbound OI process.

Secondly, we focused more specifically on the potential role of the ICT within the outbound OI phases. To cope with the absence of literature about the support of ICT to the outbound OI process, we leveraged the KM literature for finding a correspondence among the outbound OI process phases and the KM process phases. This logical shift is rooted within the nature of the outbound OI: it is a knowledge-intensive process, and this allows to single out several commonalities between it and a typical KM process (*cf.* Cepeda-Carrion *et al.*, 2010; Cheng *et al.*, 2016; Haapalainen and Kantola, 2015; Natalicchio *et al.*, 2017). In this way, we set the basis for borrowing the already-acknowledged categories of ICT tools from the KM domain (*e.g.* Griffith *et al.*, 2003; Koh and Kim, 2014; Alavi and Leidner, 2001; Von Krogh, 2012; Centobelli *et al.*, 2017) to the outbound OI environment through an appropriate contextualization. Different classifications of ICT tools for KM were analyzed within the KM stream according to their scope, their theoretical robustness, and their technological focus. Hence, three categories were selected: collaborative tools, content management tools, and business analytics.

Thirdly, according to the first two steps, we created a matrix-shaped classification framework, in which the columns indicate the outbound OI phases and the rows are the three ICT categories. This framework establishes a direct correspondence between the conceptualized outbound OI process and the ICT tools categories exploited in knowledge-intensive processes.

Definition of the outbound OI process and its phases

This section consists of two sub-sections: the first one expounds the outbound OI phases, sub-phases, and activities; the second one explains the relationship between the outbound OI activities and the KM process phases and illustrates the outbound OI framework.

The outbound OI process

After a first initial disinterest of the literature towards the process through which firms implement OI (Chiaroni *et al.*, 2009), recent work has pointed to a process-based understanding of OI, although the scientific focus has primarily been on the outside-in process (Lichtenthaler, 2011; West and Bogers, 2013; Slowinski and Sagal, 2010; Gassman *et al.*, 2010; Tavakoli *et al.*, 2017).

According to a process-based view of outbound OI, it is possible to identify two main phases (Bianchi *et al.*, 2009; Teece, 2007): (*i*) opportunity identification and (*ii*) external transfer of technologies identified in the first phases.

The first phase aims at identifying both proprietary technologies that the firm can transfer outside and the markets that can best benefit from their use. This phase implies that the company must explore markets and technologies – with the aim of searching possible applications for proprietary technologies, even in industries that are completely different from the one in which it usually operates – and must assess its technological portfolio to identify the technologies to be commercialized, according to its strategy. Consequently, this phase can be decomposed into two sub-phases, *i.e.* (*i.1*) the exploration of markets and technologies, and (*i.2*) the assessment of the company's technological portfolio.

The second phase aims at transferring outside the company those proprietary technologies which were identified in the previous phase. The transfer takes place through transactions. To do this, a company must carefully evaluate and select the actors who are potentially interested in its technologies and must choose the type of transaction that is most consistent with the achievement of the pre-established objectives.

In the following, each (sub)phase is described.

Phase i.1 - The exploration of markets and technologies

In turbulent environments, new opportunities open up for both well-established companies and "newcomers", which are able to explore both "local" and "distant" technologies and markets (Teece, 2007; March and Simon, 1958; Nelson and Winter, 1982), *i.e.* to search for information on what is occurring in the whole business ecosystem. This entails understanding customer needs, technological possibilities, latent demand, and structural evolution of markets with the final aim of searching for new applications for technologies. Such a research primarily requires the company that owns the technology to learn how to separate the technology from the context which it was conceived in and to deepen the functionalities the technology can exercise. In this phase, firms must answer questions such as: which value proposition could be created using our intellectual property? Who could be our customer? How does the potential customer perceive the value? What are its needs? Which sources can be used to acquire information? What information do we need? Once obtained, who needs this information on the company? How can we use the information obtained to exploit our assets? (Newey, 2010).

Specifically, within this set of questions, the literature has deepened specifically the sources of information that companies can address to explore markets and technologies. It emerges that sources can be both formal and informal. In this regard, external professionals – such as intermediaries and the corporate network – can be valuable information sources, at the formal and informal level, respectively. More specifically, the intermediaries, defined as "*organisations which match supply and demand of technology to facilitate IP-based transactions*" (Benassi and Di Minin, 2009), are experienced professionals who advise companies in the evaluation of their patents, in the research of new business options, and in the identification of potential partner companies (Aarikka-Stenroos *et al.*, 2014). Company networks consist of individuals (users, experts, managers and entrepreneurs), groups (collaborative communities, peer communities and sub networks) and organizations (companies, associations and universities). In particular, the presence of innovative companies in the corporate network can create new fields of activity and new markets for innovations (Möller and

Rajala, 2007; Möller and Svahn, 2009): scientific literature has shown that innovative companies can commercialize their innovations in new markets, combining them with the resources which are present in their networks (Tolstoy and Agndal, 2010). In other words, the larger the corporate network, the greater the chances of successfully running outbound OI activities.

Detecting opportunities and threats can also be facilitated if the company employs some kinds of analytical frameworks explicitly or implicitly (Teece, 2007). Companies can obtain information through patent analyses (Daim *et al.*, 2006), trend curves (*e.g.* the life cycles of technology, see Jones *et al.*, 2001), and the analysis of the S curve (Sood and Tellis, 2005; Modis, 2007; Phillips, 2007). In addition, intelligent data mining tools (Porter and Cunningham, 2005) – automatic search mechanisms for obtaining information in databases – can help companies in searching faster for the most relevant information to their goals.

Phase i.2 - Assessment of the technological portfolio

Companies often experiment great difficulties in assessing the value of their technologies and, in some cases, tend to overestimate the value which can derive from the exploitation of their technologies (Duhamel *et al.*, 2014). The assessment of the return the technology promises is very compelling as it may influence the decision about whether undertaking an innovative project (Cohen *et al.*, 2000; Levin *et al.*, 1987) or whether commercializing the technology.

At a general level, the objective of this phase is to establish how to transfer the technology, being many the variables that can affect such an assessment, *e.g.* the specific characteristics of the innovation itself, the bargaining power of the potential buyer/licensor, and the legal aspects.

The first step to carry out the assessment of the technological portfolio consists in selecting the proprietary technologies that can potentially be commercialized. In the case of the transfer of the right to use the technology, one possibility to conduct this selection is, for instance, to determine the potential royalty rate (Duhamel *et al.*, 2014) which technologies can be licensed at. Many are the factors that can play an influencing role, such as (Santiago *et al.*, 2015): the expiry of patent protection (the larger the period of protection of the technology, the grater the potential royalty rate; near the

point in time which the patent protection is close to expiry in, the potential licensee could decide not to buy the technology and to wait for the deadline, instead); the geographical coverage (if the patent is protected in a country characterized by a very competitive market, the royalty rate must be set at a minimum value, as competitive markets are characterized by an easier access); the interdependency with third parties' patents (in this case, the royalty rate strongly depends on the negotiation with third parties; in case of difficult negotiations, the royalty rate must be set at a minimum value); the compliance with regulatory and/or other legal aspects (if the commercialization of the technologies requires the State's permit, the royalty rate must be set at a minimum value).

The second aspect to carry out in the assessment of the technological portfolio consists in evaluating the effects caused by technologies when they are introduced in external environments. This requires the prediction of the possible reactions of customers, suppliers, and competitors to the introduction of technology in the market (Duhamel *et al.*, 2014). To do this, patents have to be evaluated, building on both technical and market dimensions (Santiago *et al.*, 2015). The technical dimension concerns aspects like the impact on the industry due to the innovativeness of the technology, the technological superiority over substitutes (as far as the primary characteristics are concerned), and the differentiation level (as far as the secondary characteristics are taken into account). The market dimension relates to aspects like the market potential, its contextualization in a known market trend, and the existence of a commercialization bottleneck.

Appropriate tools for carrying out the assessment phase of the technology portfolio are the analysis of the 5 Porter Forces (Duhamel *et al.*, 2014; Teece, 2007) and multi-criteria analysis to support the decision-making process.

Thus, the activities connected with the assessment of the technological portfolio phase are:

- Establishing which technologies can be licensed;
- Assessing the identified technologies from a technical and market point of view;
- Establishing the royalty rate which they can be commercialized at.

Phase ii - Technology transfer

Once an opportunity is identified and the potential value that a technology can generate when exploited outside the company is assessed, a company must evaluate how it can effectively "capture" that value.

There are different ways in which a technology can be transferred externally, and each of them entails different managerial and organizational impacts (Jeong *et al.*, 2013; Chiesa *et al.*, 2008) because of the different degrees of risk and the different potential for generating profits they imply (Jeong *et al.*, 2013; Megantz, 2002). The typologies of transaction can be divided according to what is transferred, *i.e.* the ownership of the technology or the right to use it (Chiesa *et al.*, 2008). The transfer of ownership includes all the business transactions which a complete shift of the ownership title of an asset between two involved parties takes place in, with no restrictions. Specifically, such transactions are: the assignment (sell) for money consideration, the contribution to a company (*i.e.*, a technology sale paid with shares) and the Joint Venture (JV) with selling agreement (where the new company created through the business alliance buys the technology from the owner or where the asset is assigned to the new company as equity by the owner). The transfer of the right to use includes all the business transactions which grant a restricted shift of the right to use the asset. In detail, such transactions are: the transfer of technology (the licensing of the patent and the know-how licence), the copyright licence (for the purpose of this manuscript, we refer to technological works protected by copyright, especially software), and the JV with licence agreement.

Obviously, the rate of transaction can be improved by means of proper promotion. More exactly, a company can use two different strategies: push and pull. The push strategy requires the company to actively seek potential buyers by contacting companies, exposing their innovations at fairs or commissioning intermediaries to help them in marketing. The pull strategy may rely on the exploitation of databases of patent offices and of Internet to promote not only the Intellectual Property (IP) but also the company itself as an essential player in the innovation market. These two strategies can be pursued separately or jointly. Either way, it is desirable that the IP to be promoted is supported

by a solid business case, from testimonials and/or third-party test reports and even a prototype working (Harrer and Lackner, 2014).

Results

This section presents the outbound OI framework and an example of its application.

The outbound OI framework

KM has often been conceptualized as three-phase process (Alavi and Leidner, 2001; Lindner and Wald, 2011; Durst and Edvardsson, 2012; Cerchione and Esposito, 2017): knowledge creation, in which various types of knowledge are created; knowledge storage, in which knowledge is stored; and knowledge transfer, in which the knowledge is transferred among the actors. By drawing from Cepeda-Carrion *et al.* (2010), Cheng *et al.* (2016), Natalicchio *et al.* (2017), and Haapalainen and Kantola (2015), we elicited the following elements in common between the KM process and the conceptualization of the outbound OI process we provided:

- The *Exploration of Markets and Technologies* phase involves activities ascribable to all the three KM process phases;
- The *Assessment of Technological Portfolio* phase may relate to knowledge creation and knowledge storage;
- The *Technology Transfer* phase may be linked to knowledge storage and knowledge transfer.

These similarities are not limited to the nature of the outbound OI and the KM activities, but they relate to the general objective of such activities too. Thus, we deem licit to assume that the ICT tools that can support the outbound OI process may be framed within the ICT tools categories typically associated with the KM scope.

Scientific literature has proposed different classification frameworks of ICT tools for KM. Yet, they often present some inconsistencies, or they refer to KM limited to specific activities. For instance, Elia and Corallo (2009) propose a framework built upon a *general facility* layer that underpins all the KM tools related to explicit and tacit knowledge, but they lack a stronger ICT orientation – which, in our case, should be the main one. Chen (2011) distinguishes between tools for

knowledge creation and for a vaguely defined concept of KM, without providing sufficient detail. Lee and Kelkar (2013) establish a clear relationship between ICT tools and KM but limit their inquiry to knowledge creation and transfer. Similarly, the scope of the framework by Rohajawati *et al.* (2017) is limited to knowledge sharing.

Differently, Moffett and McAdam (2003) dig into the role of ICT in KM efforts in a more critical and holistic way, building on the suitability between technology and the informational processes involved in KM. In particular, they classify the ICT tools for KM in three categories:

1. *Collaborative tools*. Technologies that engage and involve participants in a virtual community for collaborating in developing new ideas, ranging from new products or services to innovation in strategies or organizational design.
2. *Content management tools*. Technologies for event-driven or needs-based organization, collection, presentation and administration of conglomerates of information shaped according to a specific purpose.
3. *Business Intelligence*. Technologies for allowing knowledge workers "*to spot trends quickly within business, financial and market data* […] *to enable better decision-making strategies*" (p. 43).

Even though these categories tackle different KM domains, the *Business Intelligence* (BI) one leaves the door open to a misunderstanding. Traditionally, BI is an umbrella term encompassing logics and methods for improving business performance and decision making through fact-based analyses and actions (Davenport, 2006; Lim *et al.*, 2013). BI involves the exploitation of sets of techniques for data extraction, gathering, and analysis, usually named *Business Analytics* (BA). Hence, given our focus on the ICT tools only, the Business Analytics label seems to be more appropriate and focused than the Business Intelligence one, which may be excessively wide and dispersive.

According to the aforementioned similarities between KM and outbound OI, the three ICT tools

categories for KM – collaborative tools, content management tools, and business analytics – may be considered as a reference for eliciting and grouping the outbound-OI-related ICT tools from the OI and KM literature. Table 1 shows the stemming classification framework.

Table 1. The outbound OI classification framework

An example about how the framework may be practically used is discussed in the following section.

An example of application

Figure 1 shows an example of how the framework in Table 1 may be leveraged for figuring out the support that ICTs may provide to the outbound OI phases. The *Exploration of markets and technologies* phase can largely rely on Collaborative Tools for collecting data and for developing bidirectional information sharing with potential partners. For instance, e-mails, instant messaging and push technologies may foster these activities during the web navigation. Social networks allow to perform technology and market scouting by consulting companies' profiles, hashtags related to specific technologies or products, and multimedia contents concerning technology applications and market developments. Also, social networks offer wide information sharing options, which may lead to sharper and more targeted explorations.

Figure 1. An example of application of the proposed framework

Such social network capabilities, along with other technologies such as the e-conference ones, may also support the *Assessment of Technological Portfolio* phase by enabling discussions within specific groups, both public and private, and by providing additional semi- or un-structured data that may be used in the technology evaluation (*e.g.* dynamic presentations, videos). The consequent, potential *Technology transfer* may be backed up by *ad hoc* knowledge repositories (Chimm *et al*., 2017). More interestingly, this last outbound OI phase can heavily exploit Technology Transfer Platforms (*cf.* Schuh *et al*., 2013). Such platforms are increasingly spreading, *e.g. BIOSERVICE* for the biomedical

sector, *inggreen* for the environmental industry, *PTT* for general technology transfer purposes. Work Management Systems, either embedded within the Technology Transfer Platforms or as stand-alone solutions, may facilitate the execution and monitoring of the technology transfer sub-process.

Although the outbound OI phases are collaborative in nature, collaborative tools are not the only ones that can be leveraged. Among the Content Management Tools, Knowledge Repositories and Document Management Systems may support the whole process in collecting, arranging, exploiting, and sharing technology and market data and knowledge. Customer Relationship Management (CRM) systems may help in both collecting data through fetching and segmentation functionalities, which may better outline the target markets, and by analyzing such data for making quantitative-driven decisions about the technological portfolio. Such Content Management tools can be integrated with the collaborative ones, *e.g.* the CRM functionalities exploited in the exploration phase may feed an e-conference-based technology assessment (see Figure 1).

Knowledge directories may simplify data arrangement and query, clarifying the link between data and sources and identifying the knowledge owners in an organized way, *e.g.* by tree structures. Databases for semi- and un-structured data may support storage and retrieval of the most recent digital technologies, such as the above-mentioned social ones.

Finally, the current Business Analytics landscape presents several tools that can be harnessed within the outbound OI process. Social media semi-structured data may be sifted out through opinion mining and sentiment analysis tools for highlighting trends about and propensity towards specific technologies. Text mining tools, *e.g.* word clouds and word trees, may be used for better analyzing the frequency of occurrence of specific keywords within the social messages and for extracting deeper insight from them. Patent analysis tools may summarize, visualize, and share technology data in an aggregate way. Typically, Technology Transfer Platforms embed some text mining analytics for fostering faster knowledge transfer.

Thus, the proposed framework may also help a decision maker in moving forward across the whole process by following specific paths, *e.g.* those marked by red arrows in Figure 1, defining appropriate ICT-enabled strategies to capture value through the outbound OI.

Discussion and conclusions

This conceptual research offers preliminary insights on the outbound OI process and its connections with ICT tools – an important but still under-investigated topic. In particular, it sheds light on where (in which process phases and tasks) and how (which kind of coordination/communication mechanisms and technologies) ICT can foster firms implementing the outbound OI process. Drawing on the OI, ICT, and KM extant literature, we developed a conceptual framework matching the outbound OI process phases with three categories of ICT tools supporting KM by attempting to align the right technologies/tools with the appropriate process tasks.

Specifically, the implications of this research are valuable to both academics and practitioners. From a theoretical standpoint, the conceptual framework proposal fills some relevant gaps in OI literature that can be framed according to the Alvesson and Deetz (2000)'s critical management tasks, *i.e. insight*, *critique*, and *transformative redefinition*. Firstly, the insights provide a structured, systematic, process-oriented definition of the outbound OI by reporting a detailed classification of the main process phases and possible elementary tasks, describing the related process participants both inside and outside the organization. In this perspective, this work also offers a *critical* view on a major trend that interprets the outbound OI as an unstructured process, mostly driven by a creative endeavor that is not possible to frame within a structured pattern. This view has substantially limited the attempts to develop appropriate ICT solutions for supporting the OI process tasks and related actors.

Indeed, empirical studies examining OI have shown that companies seem to be mostly oriented towards inbound activities rather than outbound ones, although, by definition, a symmetry would be expected since every inbound effort from a company should lead to a reciprocal outbound effort from

another one (Chesbrough and Crowther, 2006). A possible explanation advanced by scholars (Huizingh, 2011) is that, while many organizations intentionally use external knowledge, only a few provide it, at least in a structured fashion, properly recognizing this process as outbound OI. Hence, the formalization of the outbound OI process tackles the challenge to clarify the reference context of a complex and heterogeneous pathway towards innovation. The preliminary outcome provided by this research may be an inspiring model for further theoretical studies and empirical investigations of outbound OI adoption.

Secondly, this study allows to identify the main ICT categories supporting the phases of the outbound OI process in line with a KM perspective. Akin to the inbound OI, the effective management of the outbound OI requires retrieving, integrating, and exploiting different types of knowledge by taking into account differences between recipient and sources; KM tools and ICTs can strongly support such a process. By leveraging the similarities between the OI and the KM streams, the conceptual framework provides a rationale for borrowing some ICT tools used in the KM process to the outbound OI one through an appropriate contextualization. In so doing, this work also contributes to the debate on the effectiveness, drivers, and antecedents of firm desorptive capacity (Hu *et al*. 2015; Dell'Anno and Del Giudice, 2015), *i.e.* the ability to release knowledge and technology externally, pushing out previous knowledge and/or technology by alliances with external partners or other outbound innovation trajectories. In line with Joon Mo *et al*. (2016), we suggest that the desorptive capacity, which underpins the outbound OI process, may be strongly enhanced by KM systems and effectively supported by ICT tools.

Finally, merging the two above-mentioned contributions, the framework provides guidance for further exploration about the role of ICT in outbound OI, specifically on how ICTs may support the outbound OI process phases. For instance, which ICT tools can be adopted to support specific coordination/communication activities by players in the different phases of the outbound OI process. We deem that such a framework might inspire directions for future studies on the role of digital technologies in the outbound OI context.

As regards the managerial implications, the framework and particularly the examples we reported also provide a useful guide – *a transformative contribution* – to practitioners for navigating the outbound OI process throughout its main phases and constituent tasks, through potentially available tools. This attempt presents a roadmap to better understand how the available ICT tools may be adopted to support specific requirements of the outbound OI process and to achieve the opportunities offered by the current ICT landscape. In so doing, this work draws directions for the conceptual design of an integrated ICT platform or for specializing available software solutions for supporting the different phases of the outbound OI process more directly and in a structured fashion. Conceptual design is a relevant and very resource-consuming task in designing ICT systems and can be considered as a crucial, long-term output of this research. Indeed, the relative significance of conceptual design in supporting basic design or detail design is widely recognized due to its influential roles in determining the product's fundamental features and development costs (Umeda *et al.*, 1996).

Concluding, this manuscript tries to mobilize the ICT resources to support the OI processes (Cui *et al.*, 2015) for enabling the development of an integrated ICT-based system for outbound OI. Contributing to the conception of an integrated ICT platform can be clearly considered as a step forward in the OI research, where the role of digital technologies in enabling the connectivity and collaboration among actors is still a challenging and topical research question (Bogers *et al.*, 2017).

The conceptual framework design is a first essential step to allow appropriate understanding of the possible support that ICT can offer to the OI and to start analyzing the interactions between tools and related KM areas. Although the findings from this research belong just to a preliminary stage for the achievement of the final goal, *i.e.* the development of the ICT platform, the framework may be useful for setting direction to other firms approaching the outbound OI process, as well as for software developers interested in a preliminary design of an ICT platform for outbound OI: both can be inspired by and build on the preliminary insights here provided.

The main limitations of this research are due to its theoretical nature and the limited

generalizability of preliminary findings, which mostly draw on the existing literature and concern the specific needs of the peculiar application settings. Hence, future developments of this research include: (I) refining the structure of the outbound OI process and ICT dimensions in the light of further empirical evidence; (II) further populating the conceptual framework through a systematic literature review approach; (III) extending the research to other application contexts in the OI domain to enrich and verify the preliminary insights; (IV) deepening the conceptual design of the ICT platform for outbound OI, which would set the stage for final implementation and testing phases.

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Table 1. The outbound OI classification framework

	Exploration of Markets and Technologies	*Assessment of Technological Portfolio*	*Technology Transfer*
Collaborative tools			
Content management tools			
Business analytics			

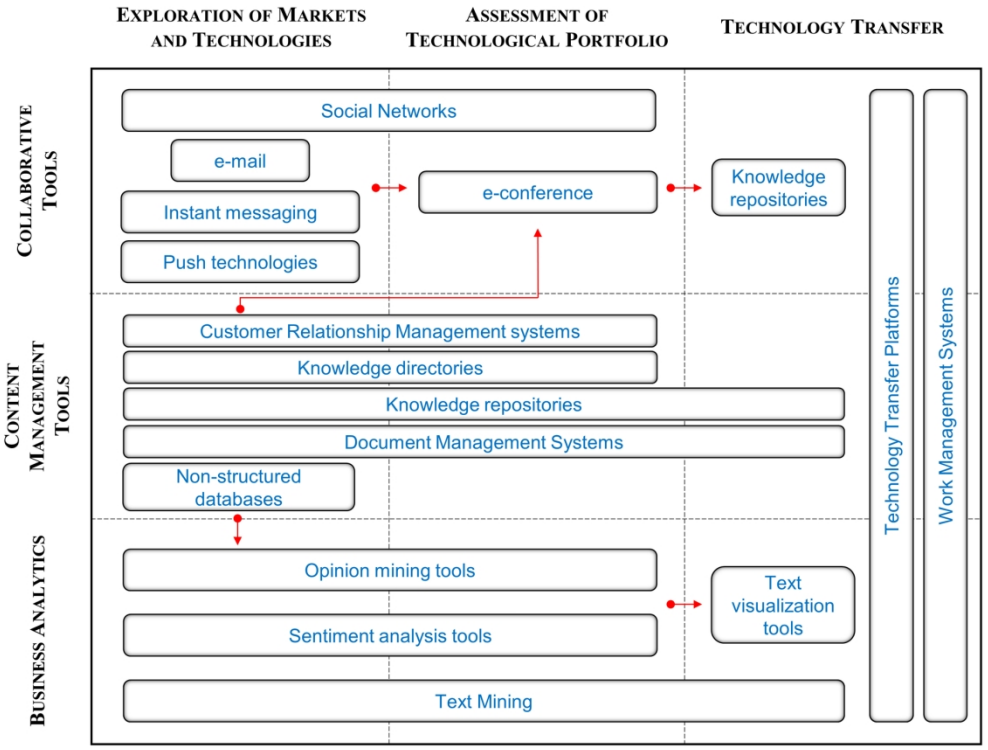

Figure 1. An example of application of the proposed framework

168x125mm (300 x 300 DPI)