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Guest Editorial

Special Issue: The digitalization of the Innovation Process: Challenges and Opportunities from a Management Perspective

Abstract

The digitalization of the innovation process seems gaining momentum in scientific literature. As various scholars have pointed out, the exponential growth in digital technologies has resulted in significant improvements to many business processes, and has also played a significant role in the field of innovation. In this special issue, we show that companies can use and implement digital technologies for different innovation-based purposes and at different stages of the innovation process. The studies are classified according to a framework that considers three topics currently being debated extensively in literature: innovation inputs, innovation processes and innovation outcomes. Because of digital technologies: (1) inputs are progressively becoming interrelated, making most of innovation endeavours happening in inter-organizational ecosystems of actors; (2) innovation processes are gradually being compressed, anticipating and enhancing the phases in which customer feedback is gathered and employed; and (3) innovation outputs are increasingly taking the form of platforms used to create value by matching the supply of an asset with demand. Further research is needed into all three directions.

Keywords: digital innovation; processes; antecedents; managerial implications; outcomes.

Introduction

Within the past decade, digital technologies have dramatically transformed the way of doing business (Gray et al., 2013). Companies are transforming themselves digitally not only as a way to re-think what their customers like (Filiari et al., 2018; Galati and Galati, 2019), but also to create operating models that can take full advantage of what is newly possible, and so differentiate themselves from their competition (Berman, 2012). In this landscape, innovation remains crucial to the development of society, to business growth and for maintaining a competitive advantage within markets (Franklin et al., 2013). On top of this, the innovation process is still an iterative, uncertain, interactive, path-dependent, context-specific and multi-tasking undertaking (Hüsig and Kohn, 2009; Pinna et al., 2018). It, therefore, remains the case that a key topic in business is to identify the right solutions for implementing a process of innovation, from the initial phase of ideation to market diffusion (Brem et al., 2016; Ganzaroli et al., 2016; Rekonen and Björklund, 2016).

The topic of digitalizing the innovation process is gaining momentum in scientific literature (Brem and Viardot, 2017). As various scholars have pointed out, the exponential growth of digital technologies has resulted in significant improvements to many business processes (e.g. Yoo et al. 2012; Levine and Prietula, 2013; Galati and Bigliardi, 2019a), and has also played a significant role in the field of innovation (e.g. Holmstrom and Partanen, 2014; Hylving, 2015).

Within this context, the term *digital innovation* has been conceptualized as “the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technologies” and, consequently, *digital innovation management* refers to the “practices, processes, and principles that underlie the effective orchestration of digital innovation” (Nambisan et al., 2017, p. 224). The need to move forward in the theory on digital innovation management was stressed in a recent special issue on this topic, in connection with the research stream of information systems (Nambisan et al., 2017). It was also emphasized that, without interdisciplinary effort and research by scholars in other disciplines (Nambisan et al., 2017) or addressing competing concerns (Svahn et al., 2017), it is unlikely that valuable theoretical advancements can be achieved.

The initial assumption in this special issue is that companies use and implement digital technologies for different innovation-related purposes and at different stages of their innovation process. Therefore, investigating the benefits, risks and implications of using digital technologies becomes highly relevant, as does learning if and how innovation processes change to accommodate, or consequently to, the use and application of digital technologies. It is also

important to know whether firms need to organize themselves internally in a different way for these technologies to be applied (Raguseo et al., 2016). Digital technologies can also be used to support knowledge management processes, with potential structural and behavioural implications (Gressgård, 2011). With respect to the structural implications, these tools can simplify access to internal and external knowledge and facilitate the dissemination of knowledge among the members of a given organization (Gastaldi et al., 2012). With respect to the behavioural implications, digital technologies can influence human interaction, and so support the development of knowledge and creation of a shared understanding between these organizational members (Gressgård et al., 2014).

The studies included in this special issue can be classified according to a framework based on an Input-Process-Output (IPO) model (Simsek, 2009; Gastaldi et al., 2018), as an IPO model is particularly useful to determine the specific contributions of the various papers. The model is shown in Figure 1 and was used to group the papers in the special issue according to their main focus. These are digital-based antecedents of the innovation process (input), how digital technologies support the innovation process (process), and the outcome of an innovation process enhanced through digital technologies (output). The rest of this paragraph covers these topics in greater detail.

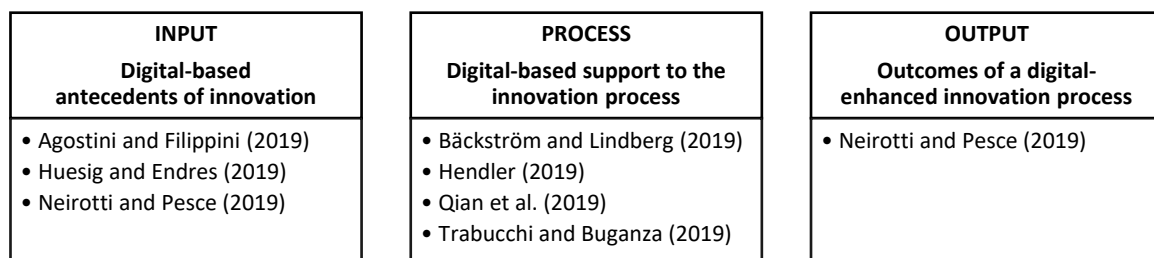


Figure 1. Classification of studies in this special issue

Input – Digital-based Antecedents of Innovation

From the literature (e.g. Lokuge et al, 2019), it is clear that technology-push innovation requires a significant accumulation of resources alongside organizational readiness. This implies that, despite the serious advancements in digital technologies, if an organization is not ready to put them to proper use, this can lead to substantial innovation opportunities being lost, or even to innovation failures.

Unlike the most anecdotes on the subject, innovation involving digital technologies is challenging and dynamic (e.g. Nambisan and Sawhney, 2011). It entails many simultaneous adjustments to organizational culture, decision-making, strategies, resources, staffing and communication (Gastaldi et al., 2015). Firms must, therefore, be ready to change their approach towards innovation on a continuous basis if they want to rely on digital technologies.

As argued in organizational change literature (Teng et al., 1998), firms produce, assimilate or exploit innovations if they perceive them as necessary and have the required capabilities. On this point, studies by Agostini and Filippini (2019), Huesig and Endres (2019) and Neirotti and Pesce (2019) included in this special issue are all concerned with investigating how digital technologies shape the organizational, technological and managerial antecedents of innovation processes.

Digital technologies can spread the idea that employees are becoming more and more focused on creative, innovative and communicative work that requires continuous improvement and learning (Raguseo et al., 2016). Therefore, the role of a company's employees is key for innovation requiring highly skilled staff (Agostini and Filippini, 2019). This entails preparing suitable training for employees and concentrating on new core tasks, such as how to manage and control digital systems. It follows that employee training and continuous professional development are of primary importance if the early stages of the transition towards digitalization are to be successful.

Beyond their skills, individuals are embedded in a social context, and they must be able to communicate, cooperate and establish social connections with other individuals and groups. Digital organizational processes that are fully integrated and automated implicitly mean that staff will have a broader scope of responsibility and need to understand the connection between processes and information flows, as well as learning how to work together to find the most appropriate ad hoc solutions for particular innovation-related issues. These issues need to be raised by managers (Kagermann et al., 2013), who must act as social mediators, shave down the hierarchical levels and give people and teams greater autonomy. This support can encourage organizational learning and innovation by increasing employee participation (Agostini and Filippini, 2019).

From a technological perspective, managers can leverage on digital advancements to improve how they deploy resources during the innovation process, but they need to identify and adopt the right digital tools. In the present special issue, in their study, Huesig and Endres (2019) explore the influencing factors behind the adoption of a particular class of software – Innovation Management Software (IMS) – and how this software can be used. Their study

advances our understanding of the technological and organizational drivers for transforming an innovation process into a digital innovation process, especially in the case of companies and innovation managers that intend to introduce IMS and use it successfully in new product development. As a consequence, the authors suggest that using digital tools within the innovation process is a more finely nuanced process than “the more–the better” logic often promoted in previous literature in this field.

Finally, in their study, Neirotti and Pesce (2019) start by assuming that the industry to which a company belongs is the factor that most influences its accumulation of intangible assets, such as digital resources. This is because all firms in a given industry tend to face similar conditions in their competitive and institutional environment, and they are also more likely to tap into the same market supply of technologies. In addition, managers tend to use their industry peers as frames of reference when making their digital strategy choices. This point should result in industry-wide commonalities, particularly in terms of the observable aspects such as the heuristics that drive digital spending and timing in the adoption of certain technologies. On this point, higher spending in innovation can often mean more complex patterns in the use of digital technologies and more sophisticated industry-specific capabilities built upon these technologies. Spending on digital technologies can also be used as a condensed variable that explains “between” sector differences concerning the extent to which digital technologies are adopted and the breadth of the associated capabilities. As a consequence, there might be a great deal of “between sectors heterogeneity” in digital spending, and this is associated to different outcomes concerning industrial and competitive dynamics.

Process – Digital-Based Support to the Innovation Process

Digital technologies enable the creation or improvement of products, processes and business models (Nambisan et al., 2017). Nambisan (2003) suggests that digital technologies support collaboration, coordination and communication amongst New Product Development (NPD) team members, and he emphasizes the role played by computer-mediated communication technologies to facilitate, intensify and expand the interaction and communication among employees executing NPD tasks. Similarly, Durmusoglu (2009) argued that, when senior management have a sophisticated view of information technology infrastructure, this leads to a more efficient NPD process, because the cycle time and cost of NPD projects is reduced and the NPD process quality is improved.

In this special issue, Qian et al. (2019) have investigated the role of web-based ideation platforms for collective idea generation and development. Their assumption is that companies are proactively trying to stimulate their employees into generating new ideas and this has prompted the academic world to direct its attention towards the management of such ideation processes. The authors found that idea development is significantly influenced by the timeliness of feedback, as well as by the overlap in knowledge between those giving feedback and those generating ideas. They found that an idea is more likely to be accepted if people are given a longer time in which to provide feedback and if there is a greater overlap in knowledge. However, after a certain point, the positive effect of longer feedback time drops, resulting in a curvilinear relationship. Their results shed new light onto collective idea development theory and have also brought up management implications on this matter and on the role of digital technologies in NPD processes.

The study by Bäckström and Lindberg (2019) also advances our knowledge on the mechanisms behind digital-enhanced Employee-Driven Innovation (EDI) through their work on examining how companies can integrate a web-based tool into their EDI process. Their results suggest that, when senior management takes over the discussions on innovation – meaning that the aspect of customer satisfaction is promoted above employee engagement – this could hinder or hold back employees from using the digital platform on which this conversation is circulated. Employee participation is, in any case, ensured because the local managers act as co-distributors of the digital tool. Their study provides practical insights into the importance of local management actively promoting these digital tools among employees to ensure their involvement. This study contributes to the EDI literature by identifying some of the mechanisms behind the process and the implications of varying levels of employee involvement in digital-enhanced EDI processes.

In addition, as highlighted by Nylén and Holmström (2015), we must also consider the new family of products frequently referred to as smart-products. These products have embedded digital components and can provide digital services that utilize the data generated. In this case, traditional product development is combined with software development practices, which differ significantly from one another (Porter and Heppelmann, 2015). Software development is optimized to a high degree of uncertainty for product requirements and solution methods, where agile development methods are employed. Physical product development, in contrast, is optimized to make stable use of investments and is based upon the high predictability of process outcomes and market demands. The study conducted by Hendler (2019) helps to shed light on questions like *“how can a company effectively coordinate the need for early specification with*

the need to keep options open until late in the process?” and “how can a company effectively coordinate a focus on efficient reuse with a focus on learning?”. The results suggest that, when combining digital and physical development processes, one or both need to change. This may lead to the sub-optimization of either or both the individual processes, but to an optimization of the combined digital-physical process. In addition, the study suggests that digital-physical process optimization requires a number of development and coordination practices, as well as the need to set in place the right contextual measures.

Finally, a number of scholars belonging to a parallel stream of research have recently started to point to the different kinds of innovation that can be pursued by exploiting one of the most exciting subjects for the digital era, big data. Chang (2018) stressed the need for further research on how big data can provide incentives to foster innovation, especially now when technological evolution enables data to be gathered in a timely and cost-effective way. Similarly, Rindfleisch et al. (2017) showed how big data can give companies the means to extrapolate value from the data (innovation from data) and to engage in a particular kind of product innovation, enabled by gathering and analysing data (innovation as data). The study by Trabucchi and Buganza (2019) examines this latter point in greater depth. They propose a data-driven approach to innovation, offering a peculiar view of the innovation process. In their perspective, the trigger point is the need for data that gives rise to the inception of the entire development process in a complex system. The fact that data are a by-product of the entire innovation process and not its primary output is an unusual and novel take on the subject.

Output – Outcomes of a Digital-enhanced Innovation Process

Prior studies on innovation have argued that there is the need for a stable or discrete set of boundaries for new product ideas (e.g. Davidsson, 2015). Digital technologies have, however, made these boundaries more porous and fluid. Moreover, the value of product/service offerings continues to evolve (Nambisan, 2017).

Most digital product designs remain to some extent incomplete. This is because nowadays, firms are increasingly putting their efforts into innovating malleable intangibles that can be rapidly reconfigured (Nylén and Holmström, 2015). It has, therefore, been highlighted that the ongoing reconfiguration of the firm’s business model is critical in a context of digital innovation (e.g. Lucas and Goh, 2009).

Indeed, digital technologies have contributed to overturning several well-established business models, because innovation is associated to a new logic and configuration for a

company's streams of revenue. As specified by Neirotti and Pesce (2019) in this special issue, innovation consisting of "doing the same things with less" has the aim of reducing operational expenses and defending a firm's profit margin from competitive pressure on prices. Alternatively, innovation grounded on making an effective use of digital technologies and "do new things" can target the firm's growth in revenue and also identify more lucrative and high-growth market segments, or even increase a customer's willingness to pay for additional products or services provided as a joint offer.

At the same time, these two types of innovation can be distributed at different rates in various industries and they can also have profound implications on industrial and competitive dynamics. Industry-level studies can contribute towards understanding the differences in the economic impact of digital innovation, especially when they can compare these effects across industries (Neirotti and Pesce, 2019).

Future Developments

Digital technologies are shaping the world we live in and the landscape in which firms have to compete and innovate. There is no end to this in sight, and this opens directions of future research that could be interesting to deepen. Starting from the IPO model used to position the papers in this special issue, we can discuss the main changes that are likely to define innovation management in the near future. Because of digital technologies:

- The antecedents of innovation processes (inputs) are becoming progressively interrelated, , making most of innovation endeavours happening in inter-organizational ecosystems of actors;
- Innovation processes are gradually being compressed, anticipating and enhancing the phases in which customer feedback is gathered and used;
- The outcome of innovation processes (output) is increasingly taking the form of platforms where value is created by matching the supply of an asset with the demand for that asset.

Each topic will be briefly detailed in the remainder of this paragraph, and we will highlight the productive avenues for further research into the digitalization of innovation process.

Input – Towards Digital-Enabled Inter-Organizational Innovation Ecosystems

Nowadays, there is a growing tendency for firms to gather into inter-organizational ecosystems where they work in cooperation with their partners, suppliers and customers, in what is

commonly referred to as an open, collaborative environment (e.g. Agostini et al., 2015; Agostini and Nosella, 2019; Galati and Bigliardi, 2019b). These ecosystems create value through complementary inputs composed of loosely interconnected independent stakeholders that share information, data and knowledge (Adner, 2006). Digital technologies play a pivotal role in these settings, as they enable assets to be exchanged more easily (Galati and Bigliardi, 2017), and also because these technologies are then utilized and recombined within the ecosystem to a greater extent than what would have otherwise been the case, and this in turn enables inter-organizational innovation processes (Wareham et al., 2014).

In many sectors – such as healthcare, financial service and renewable energy – information, data and knowledge are dispersed so widely that the only way for innovation to take place is through inter-organizational initiatives enabled and/or enhanced by digital technologies (Dougherty and Dunne, 2011).

While innovation ecosystems are more and more often being perceived as highly useful vehicles for creating and capturing value from complex value propositions (Kapoor and Lee, 2013), in current literature, there is now the assumption that these value propositions can be known ex ante and, therefore, be the basis for an appropriate ecosystem design (Nambisan and Sawhney, 2011). As suggested by Dattè et al. (2018), in most cases, the level of uncertainty is so high that the antecedents of a given ecosystem-based innovation are closely interrelated, making it impossible to create any meaningful system to oversee the inter-organizational innovation process. The process of creating and managing an innovation ecosystem increasingly depends on systematic processes driven by coupled feedback loops, and it is up to the organizations to control these dynamically (Dattè et al., 2018). Digital technologies have the potential of taking over this dynamic control, but currently we have no clear understanding of how to use these digital technologies most effectively within the continuous recombination of antecedents, a process which is the pillar of inter-organizational innovation. Further research is necessary to examine this topic more closely, and help to uncover, among other aspects: (1) how to increase digital integration among ecosystem actors, (2) which levers must be acted on to improve the organizations' dynamic control, and (3) what governance settings are most appropriate for these innovation ecosystems.

Process – Towards Compressed and Customer-Engaging Innovation Processes

Digital technologies are having an intense effect on the pace and structure of innovation processes. The malleability (e.g. re-programmability), homogeneity (e.g. standardized languages) and transferability (e.g. ease of transferring) at the heart of digital technologies

(Hinings et al., 2018) mean that not only are traditional innovation phases compressed (Nambisan, 2018), but they also enable innovative ways to carry out these innovation phases (Holmström, 2018).

For instance, artificial intelligence can be used in the downstream phases of, for example, an innovative marketing process, because processing real-time information flows throughout the lifecycle of products provides a solid data support to marketing and sales (Martínez-López and Casillas, 2013). This, in turn, can lead to improving a product on the basis of customer feedback, and also provides the opportunity for developing strong ties with customers and work in close collaboration and coordination with them. Cloud computing is another interesting example, as it can reduce costs and introduce more flexible resource management in several phases of the innovation process (Lin and Chen, 2012; Lian et al., 2014). Boss et al. (2007) have stressed how companies can use cloud computing to develop, test and make their innovations available to the user community very quickly, because it enables faster deployment cycles for new products and services.

More generally, digital technologies tend to compress innovation processes, anticipating and enhancing the phases where customer feedback is gathered and used, as suggested in Design Thinking methodologies (Micheli et al, 2019). Areas of interest for further research include: (1) the actual contributions that the various digital technologies make to the different phases of the innovation process, (2) the advantages and disadvantages linked to using digital technologies within this process, (3) how to retain a positive interplay between humans and digital technologies in an enhanced innovation process, and (4) what space is left for human creativity in an increasingly efficient and compressed process where there is a robust and continuous streams of customer feedback to be handled.

Output – Towards Platform-Based Business Models

Platforms have always been seen as an interesting model for managing new product development and innovation successfully (Figueiredo Facin et al., 2016). Companies can employ techniques such as product modularization and product platform development to expand their product range and variety, while, at the same time, keeping complexity and related costs to an acceptable level (Magnusson and Pasche, 2014).

In recent years, the focus has shifted towards conceiving platforms as the result of the wider effort of developing infrastructures and rules to enable transactions among different groups of uses in multi-faceted networks (Eisenmann et al., 2006). As suggested by Constantinides et al. (2018), some of today's most highly valued companies – including

Alibaba, Amazon, Facebook and Google – are actually platforms of this second kind. At the same time, many long-standing companies are now looking at how they can adopt platform-thinking to improve their performance.

More generally, because of the wide-spread diffusion of digital technologies, in a number of innovation processes, the output is often a platform where value is created by matching the supply and the demand side of an asset (Parker and Val Alstyne, 2018). While the concept of platform sounds simple, in reality it is a highly transformative process, and is radically changing business, the economy and society at large. As Parker et al. (2016) explain, practically any industry where information is an important ingredient is a candidate for platform development. This includes businesses whose “product” is information (such as education and media) and extends to any business where access to information about customer needs, price fluctuations, supply and demand and market trends has value – so just about every business. We know that digital technologies enhance platform development. However, we know very little about (1) the optimal platform design strategies, including aspects such as degree of openness, and how are these strategies connected to the platform owner’s innovation processes (2) the role played by complementors in the innovation process to develop a platform and leverage on it, and (3) how can firms exploit existing platforms to improve their innovation efforts. Further research should focus on these and other topics in order to gain a clear understanding of the interplay between the digitalization of the innovation process and platform management.

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