Ambidextrous organization and agility in big data era

The role of business process management systems

Riccardo Rialti
Dipartimento di Economia e Management, Università di Pisa, Pisa, Italy
Giacomo Marzi
Lincoln Business School, Lincoln, UK
Mario Silic
Institute of Information Management, Universitat Sankt Gallen School of Management, Sankt Gallen, Switzerland, and
Cristiano Ciappei
DISEI – Dipartimento di Scienze per l'Economia e L'impresa, Università degli Studi di Firenze, Firenze, Italy

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Abstract

Purpose – The purpose of this paper is to explore the effect of big data analytics-capable business process management systems (BDA-capable BPMS) on ambidextrous organizations' agility. In particular, how the functionalities of BDA-capable BPMS may improve organizational dynamism and reactiveness to challenges of Big Data era will be explored.
Design/methodology/approach – A theoretical analysis of the potential of BDA-capable BPMS in increasing organizational agility, with particular attention to the ambidextrous organizations, has been performed. A conceptual framework was subsequently developed. Next, the proposed conceptual framework was applied in a real-world context.
Findings – The research proposes a framework highlighting the importance of BDA-capable BPMS in increasing ambidextrous organizations' agility. Moreover, the authors apply the framework to the cases of consumer-goods companies that have included BDA in their processes management.
Research limitations/implications – The principal limitations are linked to the need to validate quantitatively the proposed framework.
Practical implications – The value of the proposed framework is related to its potential in helping managers to fully understand and exploit the potentiality of BDA-capable BPMS. Moreover, the implications show some guidelines to ease the implementation of such systems within ambidextrous organizations.
Originality/value – The research offers a model to interpret the effects of BDA-capable BPMS on ambidextrous organizations' agility. In this way, the research addresses a significant gap by exploring the importance of information systems for ambidextrous organizations' agility.

Keywords Information systems, Big data, Agile, Agility, Ambidexterity

Paper type Conceptual paper

1. Introduction

For decades, scholars have proposed theories to explain organizations' inability to make steady improvements to existing businesses, to adopt innovations or to adapt to the changing environment (Raisch *et al.*, 2009; Del Giudice and Della Peruta, 2016; Marzi, Dabić, Daim and Garces, 2017). They have largely concluded that improvements or adaptations were not possible as the companies in question lacked agility (O'Reilly and Tushman, 2008). Numerous

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solutions, however, have been proposed in order to motivate companies to improve their agility and performance by using cross-functional teams or a dynamic capabilities approach (O'Reilly and Tushman, 2013). Based on the poor results achieved by companies which tried to improve their agility, O'Reilly and Tushman (2008) brought attention back to companies which successfully survived in the present competitive environment by separating their units into explorative and exploitative units. Such organizations have been identified by scholars as ambidextrous organizations – characterized by their decentralized structure, common culture and vision, and separated explorative and exploitative units (Tushman and O'Reilly, 1996). Scholars have subsequently sought to hypothesize the ways in which these organizations have managed to successfully strive in a constantly changing environment (O'Reilly and Tushman, 2008). Ambidexterity, in fact, has been deemed related to both increases in organization agility and performance (Vrontis *et al.*, 2017). Previous literature has moreover stressed out how ambidextrous organizations, which are characterized by higher degrees of agility, are more able to adapt to evolving situations (Lee *et al.*, 2015; Bresciani *et al.*, 2017).

Approaching from this perspective, information systems scholars have also observed that adequate information systems could potentially help an organization to fully exploit the benefits arising from ambidexterity (Gothelf, 2014; Lee *et al.*, 2015). It has been highlighted that such systems may have a crucial role in business processes management and, in turn, may improve consumer satisfaction, allowing for rapid answers to market changes and fostering intra-organizational collaboration – all traits relating to ambidextrous organizations' agility (Gao, 2013; Scuotto *et al.*, 2016, 2017; Marzi, Caputo and Dabic, 2017). In the current digital era, traditional information systems for business process management may, however, prove to be insufficient to enable organizations to harvest the opportunities arising from the complex digitalized environment surrounding them (Campos and Sanchez, 2003; Lock Lee, 2005; Del Giudice and Straub, 2011; Bresciani *et al.*, 2017). As a result of this, current information systems for business process management need big data analytics (BDA) capabilities in order to fully explore and exploit opportunities hidden within the increasing amount of unstructured data (Lopez-Nicolas and Soto-Acosta, 2010; Khan and Vorley, 2017; Sivarajah *et al.*, 2017).

Several studies have hypothesized the ways in which information systems may have a crucial role for ambidextrous organizations (Roberts and Grover, 2012; Bresciani *et al.*, 2017); however, the majority of literature has not considered how the emergence of big data has revolutionized the characteristics and capabilities of information systems (Yin and Kaynak, 2015). At present, BDA-capable business process management systems (BPMS) can constantly monitor processes and provide information to the right actor involved in process management (Gao, 2013). There is thus a subsequent need to investigate how such systems may increase ambidextrous organizations' agility (Lee *et al.*, 2015). The capabilities of such systems in improving exploration and exploitation capabilities of those organizations will also be explored (Wamba and Mishra, 2017). In this vein, the research aims at exploring the role of BDA-capable BPMS in fostering ambidextrous organizations' agility. Throughout this, the authors theorize a conceptual framework emerging from pertinent literature on the integration of BDA in business processes (Mishra *et al.*, 2017; Wamba and Mishra, 2017). Hence, an interpretation of the importance of BDA-capable BPMS will be provided. Moreover, to ground our findings, the framework has been applied to the cases of ambidextrous consumer-goods companies that have recently integrated BPMS with BDA.

The principal results of this paper relate to exploring the effects of BDA-capable BPMS on ambidextrous organizations' agility by identifying the touchpoints between those two streams of literature. The proposed framework, which has been enriched with insights from the application of the framework in a real-world context, also provides commentary along with several potential implications for practitioners.

In this paper, first, we present the theoretical foundations of ambidexterity and the importance of BDA-capable BPMS. The insights of existing literature have been presented

in next section in order to create a conceptual framework explaining the phenomenon. Next, the framework has been applied to the case of ambidextrous consumer-goods companies. Finally, managerial implications have been discussed.

2. Theoretical background

2.1 Ambidextrous organizations and agility

The notion of ambidextrous organization was first theorized by Duncan (1976) as a response to the switch from a static to a dynamic competitive environment experienced by organizations in the 1970s. During the years, the concept of ambidexterity in organizational studies has undergone numerous contributions that enriched it with both theoretical and empirical evidences (Gibson and Birkinshaw, 2004; Raisch *et al.*, 2009). Several scholars have demonstrated that the organizational ability to pursue two dissimilar things at the same time, i.e. manufacturing efficiency and flexibility (Raisch *et al.*, 2009); differentiation and low-cost strategic positioning (Porter, 1980); and global integration and local responsiveness (Junni *et al.*, 2013) seems a determinant of organizations' survival and performance (Zollo *et al.*, 2015, 2016; Marzi, Zollo, Boccardi and Ciappei). Consequently, an ambidextrous organization is thus identifiable as an organization capable of simultaneously exploring its environment and exploiting emerging opportunities or, in other words, an organization capable of pursuing current processes while continuously adapting to the changing competitive environment (Junni *et al.*, 2013). Exploration includes the ability of an organization to search, take risks, discover and innovate in order to prepare the field for the exploitation task (Guisado-González *et al.*, 2017). Exploitation, instead, involves the ability of an organization to implement innovation, produce, optimize and execute tasks (Duncan, 1976).

According to Lu and Ramamurthy (2011), ambidexterity naturally encompasses the concept of agility. Zain *et al.* (2005) identify how an organization aiming for agility has "to be quick in assemble [*sic.*] its technology, employees, and management with communication infrastructure in responding to changing consumer demands in a market environment of continuous and unanticipated change" (p. 831). There are several studies that show evidences of ambidextrous organizations' agility. According to Lubatkin *et al.* (2006), an ambidextrous organization could rapidly respond to market changes whilst focusing on maintaining the satisfaction levels of their existing consumers, which assesses how happy consumers are with the organizations' offerings (Rialti *et al.*, 2016). The organizational and technical flexibility, or the organizations' capability of conveniently adapting to change, has emerged then as a fundamental competitive characteristic of agility in an ambidextrous organization (O'Reilly and Tushman, 2013; Caniëls *et al.*, 2017; Vrontis *et al.*, 2017). Ambidextrous organizations characterized by agility require dynamic BPMS in order to increase dynamism and improve processes monitoring and, consequently, improve performance (Kortmann *et al.*, 2014; Wu and Chen, 2014; Vrontis *et al.*, 2017). Such evidences of agility within ambidextrous organizations and their importance are listed in Table I.

The six evidences illustrated in the above table (Table I) retrace what Lu and Ramamurthy (2011) empirically found in organizations which were deliberately pursuing organizational agility. The authors identified two types of outcome related to pursuing organizational agility: market capitalizing and operational adjustment agility. The first refers to the ability to quickly respond to and exploit changes by uninterruptedly monitoring and speedily improving products/services to address consumers' needs. The latter refers to the organization's ability to successfully and rapidly cope with market or demand changes. The six evidences in Figure 1, respectively, converge the two sides of organizational agility as descriptive traits of market capitalizing agility and operational adjustment agility, as suggested by Sambamurthy *et al.* (2003).

Therefore, the more the environmental dynamism increases, the more an ambidextrous organization is likely to benefit from the dual capacity of exploration and exploitation

Table I.
Evidences of agility within ambidextrous organization paradigm

Evidences of agility of ambidextrous organizations	
E1 – constant customers' satisfaction focus	An ambidextrous behavior leads to better performance in satisfying costumers' needs (Lubatkin *et al.*, 2006)
E2 – capability to rapidly response to market changes	Combined market exploration and market exploitation has complementary interaction effects on organizations' ability to adapt to market changes (O'Reilly and Tushman, 2008)
E3 – pursue organizational flexibility	Organizational ambidexterity permits organization to be environmentally aligned and efficient, fostering the relationship between contextual structures and organizations' performance (Gibson and Birkinshaw, 2004; Raisch *et al.*, 2009)
E4 – achieve and maintain technical flexibility	Operational ambidexterity positively affects the organizations' response to environmental uncertainty fostering manufacturing flexibility and organizations' performance (Wei *et al.*, 2014; Kortmann *et al.*, 2014)
E5 – embrace dynamic business process management	Coordination flexibility and resources flexibility have a positive effect on organizations' processes performance (Wei *et al.*, 2014; Kortmann *et al.*, 2014)
E6 – pursue effective strategic collaboration with partners	Ambidextrous organizations create better strategic alliances with partners and effectively integrate their knowledge in shared project (Lin *et al.*, 2007)

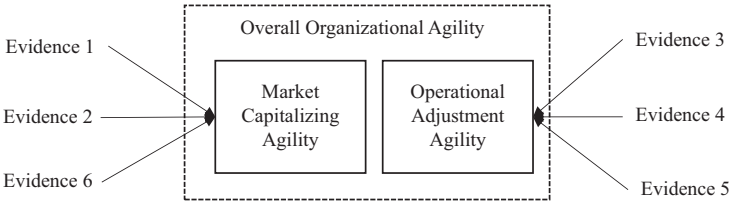


Figure 1.
Organizational agilities' evidences within market capitalizing and operational adjustment agility

(Lee *et al.*, 2015). Hence, market capitalizing and operational adjustment agility are two fundamental outcomes of the pursuit of agility, and may be considered paramount in fully taking advantage of exploration and exploitation functions simultaneously and effectively (Lu and Ramamurthy, 2011; Carayannis *et al.*, 2017; Vrontis *et al.*, 2017).

However, several studies highlight the crucial role that information systems play in enabling the information workflow needed to fully foster agility in the whole organization (Ferraris *et al.*, 2017a; Bresciani *et al.*, 2017). As a result, it is not possible to separate an ambidextrous organization characterized by a high degree of agility from an efficient and flexible information system (Tallon and Pinsonneault, 2011). This is particularly true in the current digital era, which is characterized by the need to proficiently collect and exploit huge quantities of data. Considering this perspective, the next section will explore the importance of BDA-capable BPMS (Gao, 2013) with regard to ambidextrous organizations' agility.

2.2 Big data, BPMS and ambidextrous organizations' agility

Recently, the expression "big data" has been used to describe data sets so complex that they cannot be managed or analyzed using traditional data analysis software (De Mauro *et al.*, 2017). Despite the abundant information such data sets contain, big data are usually large, heterogeneous and unstructured data sets that cannot be explored by following usual approaches (Yin and Kaynak, 2015). Big data differs from traditional massive or large data sets in terms of volume, velocity, variety, veracity and value – labeled as the five V's of big data (Wamba *et al.*, 2017). The "volume" of big data is related to dimensions where it exceeds a terabyte (McAfee and Brynjolfsson, 2012). Indeed, large organizations collect several terabytes or petabytes of data daily from their interactions with consumers, from internal processes, or from the internet (Del Giudice, 2016; Santoro *et al.*, 2017). The "velocity" of big data is defined as the "rate at which data are generated and the speed at

which it should be analyzed and acted upon" (Gandomi and Haider, 2015, p. 138). Specifically, to fully exploit big data, organizations should be capable of analyzing it in real time (IBM, 2012). The "variety" of big data refers to the heterogeneous sources of big data (i.e. sensors embedded in machines, consumers' activities on social media, B2C or B2B digital interactions, etc.) and the consequent heterogeneous formats that the files composing big data may assume (Wamba *et al.*, 2015). "Veracity" is related to the trustworthiness of the majority of data sources (Mishra *et al.*, 2017) and, finally, "value" highlights the economic value of insights extracted from big data. Large data sets that don't contain meaningful information may therefore not be considered big data (Yin and Kaynak, 2015). In addition to these characteristics, there are other potential V's that characterize big data in literature. SAS (2016) has suggested that "variability", i.e. the variation in data flow rate, may be an additional trait of big data (Mishra *et al.*, 2017). Similarly, "visualization," the possibility to visualize digitally the insights from big data, has been considered a big data characteristic (Lugmayr *et al.*, 2017). This has expanded the number of V's to 7, namely, volume, velocity, variety, veracity, value, variability and visualization (Mishra *et al.*, 2017).

Because of several successful implementations of BDA systems within organizations, McAfee and Brynjolfsson (2012) seminally identified big data as the next revolution in management (2012). BDA allow managers "to measure and know radically more about their business and to directly translate that knowledge into decision making and performance" (p. 4). Managers may take decisions on the basis of BDA systems, enabling more effective decision making (Del Giudice *et al.*, 2016; Pauleen and Wang, 2017). On the one hand, big data allows the streamlining of internal processes by reducing bottlenecks, thereby increasing efficiency (Davenport, 2014). On the other hand, managers may identify consumers' common behavioral patterns and tailor their offerings and the prices according to consumers' preferences based on insights coming from consumer-originated big data (Hofacker *et al.*, 2016). The BDA-capable BPMS adoption within the business may thus lead to increased consumer-centricity, operational optimization, improved risk management, better workforce utilization and even new business models (Motamarri *et al.*, 2017).

In order to unleash the potential of big data, information systems scholars and practitioners have stressed the importance of integrating BDA capabilities into BPMS (Gao, 2013; Wamba and Mishra, 2017). BDA-capable BPMS have been identified as information systems spanning the whole organization, capable of collecting huge quantities of data arising from business processes, analyzing data in real time and communicating the results of this analysis to all the actors involved in the process (Wamba and Mishra, 2017). BDA-capable BPMS shares many characteristics with traditional BPM systems, i.e. they aim toward promoting efficiency, effectiveness and innovation, but they differ in a fundamental aspect from traditional ones. Embedding BDA in BPMS may give "process participants better real-time situational awareness and the ability to tailor their responses appropriately" (Gao, 2013, p. 4). According to Vossen (2013) and Vera-Baquero *et al.* (2015), BDA-capable BPMS need to be analytical, automatic, adaptive and agile to leverage big data (Hill and Schulte, 2011; Gao, 2013) and this makes the system capable of advanced analysis while automatically processing data from several different business processes (Wamba and Mishra, 2017). Additionally, when applied to two or more related organizations, these systems may foster inter-organizational information exchange (Vera-Baquero *et al.*, 2015). Moreover, if such BPMS are adaptive, they may adapt to changing situations and to the evolving of more complex data.

BDA-capable BPMS show potential in fostering organizational flexibility, agility and dynamism. Specifically, on the one hand, such systems may lead to better performance in satisfying costumers' needs, allowing for rapid responses to market changes and improving intra-organizational collaboration (Wamba and Mishra, 2017; Scuotto *et al.*, 2017).

Their implementation is therefore related to organization market capitalization agility. On the other hand, it is possible to observe the ways in which they are related to operational adjustment agility (Lu and Ramamurthy, 2011). BDA-capable BPMS may simultaneously analyze data originating from several internal business processes and, consequently, allow managers to improve the efficiency of internal business processes. BDA-capable BPMS, therefore, may also potentially improve organizations' exploration and exploitation capabilities (Sivarajah *et al.*, 2017).

Although there has been significant research on the importance of information systems in ambidextrous organizations (Bresciani *et al.*, 2017), systems of relevant importance, like BDA-capable BPMS, have not been studied extensively. In fact, due to their characteristics, BDA-capable BPMS may be instrumental in increasing ambidextrous organizations pursuit of agility. Moreover, such systems may also affect market capitalizing and operational adjustment agility.

3. BDA-capable BPMS and ambidextrous organization's agility: conceptual framework's development and application

In this section, we will discuss why BDA-capable BPMS are fundamental for ambidextrous organizations pursuing agility and the outcomes of these systems' implementation. Specifically, the authors have attempted to tie up existing findings on the outcomes of BDA-capable BMPS' implementation with pertinent literature on ambidextrous organizations' agility. Then, some propositions have been developed and positioned within the hypothesized conceptual framework. Next, some corroborations about the veracity of the framework have been provided by applying it to a real-world context. This approach correlates with previous research on emerging managerial phenomenon involving technological advances (see Kim and Ramkaran, 2004; Niehaves and Plattfaut 2011; Caputo *et al.*, 2016). Indeed, studies analyzing the impact of contemporary technological advances on managerial practices may provide stronger evidence by using cases from leading organizations (Caputo *et al.*, 216). In this sense, because the adoption of BDA-capable BPMS may have a disrupting impact on organizations, an approach not exclusively focused on a theoretical perspective may represent a suitable solution (Gandomi and Haider, 2015). Therefore, some implications of BDA-capable BPMS adoption from leading ambidextrous organizations could be useful to refine the proposed framework.

3.1 From big data to ambidextrous organizations' agility

Big data has dramatically changed the competitive landscape in which organizations operate (McAfee *et al.*, 2012). In order to gain a competitive edge, actually, organizations should adopt information systems capable of extracting meaningful information from unstructured data sets. BDA-capable BPMS emerge as fundamental (Gao, 2013) as they can collect data from several different business processes, analyze them and provide the right information to the right actors involved in business process management (Vossen, 2013). First, by adopting BDA-capable BPMS, organizations can better manage their data as BPMS, and indeed, can collect data from consumers, allowing organizations to monitor existing consumers' activities and interactions on firm-initiated online platforms (Gunasekaran *et al.*, 2017). In particular, BDA-capable BPMS could simultaneously track and analyze consumers' behavioral pattern, gather feedback on products and, additionally, communicate information simultaneously to marketing department (Hofacker *et al.*, 2016; Rialti *et al.*, 2016). BDA-capable BPMS can then increase consumers' satisfaction by offering consumers' tailored offerings, both with regard to product characteristics and pricing (Gunasekaran *et al.*, 2017). Consequently, these

systems have a crucial role in increasing organizations' reactiveness to market changes (Sivarajah *et al.*, 2017). Likewise, in terms of stakeholder management, these systems can improve processes involving external stakeholders by monitoring interactions and allowing organizations to analyze data in real time (Hahn *et al.*, 2016). Additionally, BDA-capable BPMS may be useful for improving relationships with partners (Gao, 2013), as such systems can ensure the necessary information flow between involved parts (Bresciani *et al.*, 2017). Shared analytical architectures based on cloud computing may indeed allow two partners to work contemporaneously on the same data set, thus allowing the exchange of insights and of results (Scuotto *et al.*, 2017). In a similar fashion, BDA-capable BPMS can improve the collaboration between two different business units within the same organization (Hahn, *et al.*, 2016; Sivarajah *et al.*, 2017). Finally, because of their analytical capabilities, by adopting an internal processes management perspective, BDA-capable BPMS could identify bottlenecks in internal processes such as production processes or information sharing processes (Wamba and Mishra, 2017). Therefore, these systems may increase the speed of the decision process, increase organizations' dynamism and foster ambidextrous organizations pursue for agility, which is related to the notion of velocity in decision making and consequent actions. They could thus subsequently foster real-time operational adjustment and increase efficiency (Roberts and Grover, 2012). Hence:

(1) BDA-capable BPMS could foster ambidextrous organizations' agility as they allow for the monitoring of both consumers' behavioral pattern and internal processes while simultaneously proving an information flow to the actor involved in process management. Hence, they may increase the velocity of the decision-making process, which is coherent with ambidextrous organizations' pursuit of agility.

According to Lu and Ramamurthy (2011), organizations' attention toward consumers' satisfaction level, the capability to act promptly in response to market change, the possibility to ensure consumers' satisfaction and the existence of an effective mechanism to collaborate directly with partners are related with ambidextrous organizations' pursuit of agility. The ability to better identify and capitalize markets' emerging opportunities has been deemed fundamental for ambidextrous organizations aiming to reach market capitalization agility (Roberts and Grover, 2012). Similarly, ambidextrous organizations characterized by a high degree of agility may potentially achieve operational adjustment agility. Organizations deeply committed to embracing dynamic business process management and achieving technical and organizational flexibility may be capable of identifying eventual inefficiencies in internal processes and may be able to adjust production quantity according to the need (Wei *et al.*, 2014). Such organizations also tend to show higher production efficiency levels (Lu and Ramamurthy, 2011). The market capitalizing and operational adjustment agility are potentially two outcomes of ambidextrous organizations' pursuit of agility (Gothelf, 2014; Lee *et al.*, 2015). Identifying opportunities in the market and predicting the possibility of reaping the benefits are consequences of the agility of ambidextrous organizations which, in turn, is connected with ambidextrous organizations' exploration and exploitation capabilities (Junni *et al.*, 2013). Hence:

(2) Ambidextrous organizations pursuing agility may achieve market capitalizing agility.

(3) Ambidextrous organizations pursuing agility may achieve operational adjustment agility.

Information systems such as BDA-capable BPMS may have a crucial role and may act as facilitators in ambidextrous organizations pursuing organizational agility (Tallon and Pinsonneault, 2011). They allow organizations to collect and analyze, simultaneously,

information from external and internal sources (Overby *et al.*, 2006; Nazir and Pinsonneault, 2012). Consequently, BDA-capable BPMS are fundamental in speeding up decision making and in consequently harvesting the benefits arising from pursuing agility (Davenport, 2014).

Therefore, ambidextrous organizations characterized by high levels of agility may achieve market capitalization agility and operational adjustment agility (Lu and Ramamurthy, 2011). First, BDA-capable BPMS can indeed enable ambidextrous organizations to better identify market trends, opportunities and emerging niches before competitors (Overby *et al.*, 2006; Gunasekaran *et al.*, 2017). Second, BDA-capable BPMS may allow ambidextrous organizations to reduce the wasting of productive factors (Dubey *et al.*, 2017) and to regulate the flow of production, thus also reducing stock inventories (Sivarajah *et al.*, 2017). Consequently, they could facilitate organizations simultaneous exploration and exploitation functions (Gao, 2013; Santoro *et al.*, 2017). This is particularly true in the current environment, where data analytics capabilities are vital (Chen *et al.*, 2014; Khan and Vorley, 2017). Hence:

(4) BDA-capable BPMS may act as facilitators for ambidextrous organizations, characterized by high degree of agility, to achieve market capitalizing and operational adjustment agility. Indeed, such BPMS allow both to better identify market opportunities and to exploit those latter efficiently.

Additionally, seeing as organizations that have achieved operational adjustment agility are more prone to embrace dynamic business process management and adopt innovative information systems (Kalpič and Bernus, 2006; Wei *et al.*, 2014), we hypothesize that ambidextrous organizations characterized by a high level of agility may be more likely to adopt innovative BPMS or to improve existing ones (Leonhardt *et al.*, 2017; Santoro *et al.*, 2017). Actually, ambidexterity tied up with ad hoc information systems may foster the knowledge absorption and sharing capabilities of the organization (Cegarra-Navarro *et al.*, 2017; Pauleen and Wang, 2017; Vrontis *et al.*, 2017), which is vital for technology adoption (Santoro *et al.*, 2017). In the particular case of BDA-capable BPMS, their adoption may be grounds for the adoption of new systems, thanks to the training received by the workforce (Ferraris *et al.*, 2017a). Moreover, seeing as they facilitate the diffusion of information within the organization, it is quite feasible that these systems are invaluable in the adoption of innovations as they allow all actors to receive the necessary information (Zain *et al.*, 2005; Guisado-González *et al.*, 2017). Hence:

(5) Organizations that have achieved operational adjustment agility are more likely to innovate current process management systems or to adopt more innovative ones.

The five propositions have been used to develop the following conceptual framework in order to explain how BDA-capable BPMS may be fundamental in fostering ambidextrous organizations' agility (Figure 2). The framework reassumes the underlying mechanisms that relate the adoption of BDA-apable BPMS to market capitalizing and organizational adjustment agility. In particular, we have highlighted how, thanks to faster decision-making processes and a smoother flow of information, an organization may be able to better identify and exploit market opportunities while contemporaneously increasing internal efficiency.

3.2 Refining the conceptual framework: some evidence from an application to consumer-goods companies

To corroborate the initial proposed framework, we apply the proposed model to one specific typology of organization: consumer-goods companies. Consumer-goods companies are one of the principal typologies of large organizations (Porter, 1980). They frequently operate in

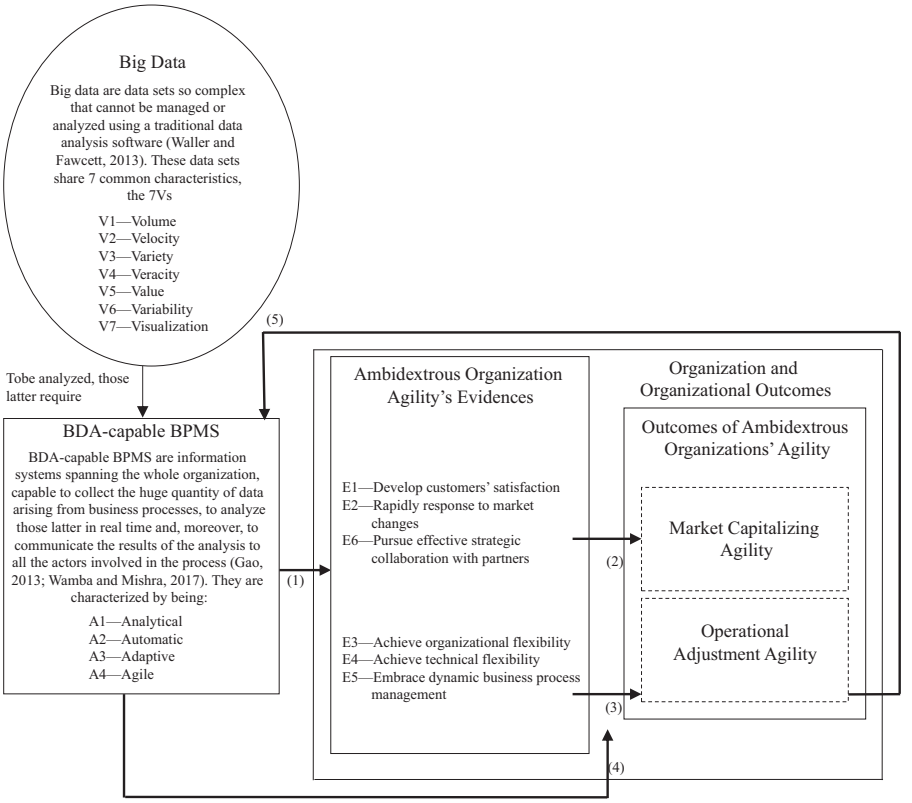


Figure 2.
The importance of BDA-capable BPMS for ambidextrous organizations' agility

different markets, with regard to both products and geographical context and, moreover, the majority of consumer-goods companies trace their origins back through the twentieth century (Porter, 1974). This notwithstanding, consumer-goods companies have traditionally focused on innovating products and services to strive in a competitive arena (Barras, 1986). Indeed, according to Chui and Fleming (2011), consumer-goods companies are leading the big data revolution together with banks, retailers and social media. Interestingly, consumer-good companies' have applied BDA also on production side cannot; hence, it is possible to observe how BDA-capable BPMS could affect production efficiency. In addition to this, because consumer-goods companies are frequently characterized by different units delegated to exploration and exploitation, they frequently share some traits of ambidextrous organizations (Tushman and O'Reilly, 1996; O'Reilly and Tushman, 2013). Thus, consumer-goods companies represent a suitable opportunity to apply our framework to a real-world context. Moving from these considerations, the authors have consulted both practitioner-oriented literature and three senior and junior data analysts from large US-based consumer-goods companies. This enabled the authors to refine the framework, gather some insights from practice and ground the framework in the identified setting.

With this in mind, adopting a production side-based point of view, the integration of BDA within BPMS has been identified by practitioners as vital in increasing consumer-goods companies' productivity. Specifically, it may lead to the prevention of potential disruptive machinery-related issues, which has been stressed as the greatest potential of BDA-capable

BPMS on production side. The possibility of BDA to estimate machinery-related failure rates may predict potential emerging problems (Chui and Fleming, 2011). Machine learning-based algorithms, moreover, have been deemed capable to suggest to workers potential ways of acting more precisely amidst technical problems (Caputo *et al.*, 2016). BDA-capable BPMS can therefore increase the efficiency of production processes, which is coherent with the operational and technical flexibility that ambidextrous organizations may reach as a consequence of implementing this kind of BPMS system. Consumer-goods companies may consequently aim toward achieving fully data-driven production-side business processes management.

Despite this, the greatest impact of BDA-capable BPMS concerns organization market capitalizing agility. As a consequence of BDA-capable BPMS adoption, consumer-goods companies can identify previously neglected niches of consumers, which may prove to be extremely profitable. In fact, traditional marketing analysis systems have been deemed unreliable as they are not always capable of properly identifying smaller niches due to their limited analytical capabilities (Hofacker *et al.*, 2016). Moreover, through confrontation with practitioners, it has emerged that the analytical power of BDA-capable BPMS are fundamental for consumers' life-time value predictions in consumer-goods companies. BDA-capable BPMS applied to consumer-goods companies are capable of predicting which consumers will purchase company products again and which ones will not. Therefore, they allow for the improvisation of sales-revenue management by providing marketers with relevant insights on which consumers are not as profitable. This is fundamental in consumer-goods companies, which usually sell low-margin products. Finally, automatic BDA-capable BPMS are relevant for developing online customized marketing campaigns, which have been linked to consumer satisfaction (Rialti *et al.*, 2017). For this reason, the implementation of BDA-capable BPMS is linked to market capitalizing agility.

Concerning the production side, such BPMS can plan production according to predicted sales volumes (Deloitte, 2017). Similarly, BDA-capable BPMS offer consumer-goods companies the possibility to share data with their B2B partners (Sivarajah *et al.*, 2017). Hence, consumer-goods companies may constantly monitor partners stocks and predict when a partner may need more supplies (Chui and Fleming, 2011).

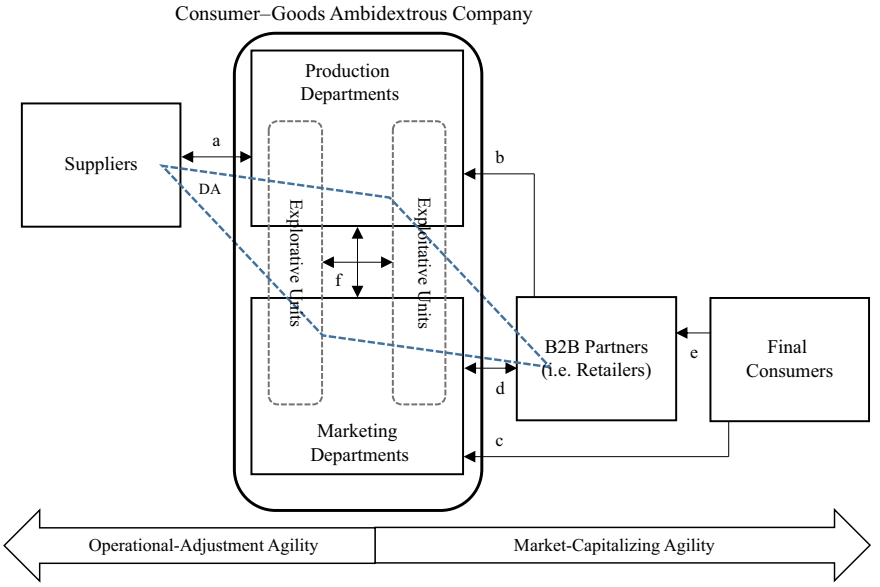
Concerning ambidextrous consumer-goods companies, moreover, from a practitioner's point of view, BDA-capable BPMS can tie up the explorative and exploitative units. In particular, they can ensure the information flows from the explorative unit to the exploitative one. An example of this can be found in the possibility of uncovering unexpected niches and in targeting them properly. BDA-capable BPMS, then, because they could identify and exploit opportunities, can increase the speed of decision-making processes and, overall, ambidextrous consumer-goods companies may better achieve agility and technical flexibility.

Moving from these insights, a framework specifically concerning ambidextrous consumer-goods companies has been developed (see Figure 3). The new framework illustrates in greater detail the possible outcomes on production and marketing of the implementation of BDA-capable BPMS in ambidextrous consumer-goods companies (De Mauro *et al.*, 2017). Moreover, it also stresses how BDA-capable BPMS have the potential to improve relationships with partners.

4. Implications of the research

4.1 Theoretical implications

The research provides some preliminary insights on the perspective importance of implementing BDA-capable BPMS within ambidextrous organizations. In particular, it has been hypothesized that systems capable to collect unstructured data and to analyze these data in real time may present a competitive advantage for ambidextrous organizations



Notes: DA, shared data-architectures – like data-lakes – structured by a consumer-goods company, connecting consumers-goods company with supplier and B2B partners (Scuotto *et al*., 2017). [a]BDA-capable BPMS allow bi-directional data flow from suppliers to production department of consumer-goods company (Gao, 2013; Chui and Fleming, 2011); [b]BDA-capable BPMS allow data flow from B2B partners to production department of consumer-goods company (Vera-Baquero *et al*., 2015); [c]BDA-capable BPMS allow data flow from final consumers to marketing departments of consumers-goods company – those data could also be collected by data architectures (Gao, 2013; Bresciani *et al*., 2017); [d]BDA-capable BPMS, tied-up with shared architectures, allow bi-directional communication and data sharing between marketing departments of consumer-goods company and B2B partners (Gao, 2013; Chui and Fleming, 2011); [e]B2B partners may collect data from final consumers thank to data collection systems (Lee *et al*., 2015); [f]BDA-capable BPMS could connect different units within a consumer-goods company. In particular, they could foster connection between marketing and production departments or between explorative and exploitative units (Chui and Fleming, 2011; De Mauro *et al*., 2017)

Figure 3.
Evidence of BDA-capable BPMS in consumer-goods company

looking to increase their flexibility (Vossen, 2013). Such BPMS, in fact, may extract meaningful information from complex big data and simultaneously inform the actors involved in BPM (Mishra *et al*., 2017). The informative potential of big data may be unleashed by BDA-capable BPMS (Gao, 2013; Rothberg and Erickson, 2017). Subsequently, the manager may receive immediate information concerning changes occurring at consumer, partner and internal levels (Wamba and Mishra, 2017). As a consequence of the constant flow of information, therefore, managers and actors involved in processed management may act promptly to implement strategies in response to environmental changes, all to the organization's benefit (Maier and Remus, 2003; Ferraris *et al*., 2017a). This relates with the findings from the application of the framework to consumer-goods ambidextrous companies, which provides some insight on the ways in which BDA-capable BPMS may be able to identify new opportunities and exploit them properly without wasting resources. Moreover, it also seems that BDA-capable BPMS allow to better link internal units of ambidextrous consumers-goods companies (Chui and Fleming, 2011).

Due to their characteristics, moreover, BDA-capable BPMS can be technically capable of increasing ambidextrous organizations dynamism. Indeed, the information flow from such systems allows the manager to know, better than ever, their business and competitors, as previously assessed by McAfee and Brynjolfsson (2012). Such systems can prospectively allow managers to better known consumers, collaborate with partners and embrace a constant internal and external BPM (Roberts and Grover, 2012; Lee *et al.*, 2015; Bresciani *et al.*, 2017). Such BPMS may thus increase ambidextrous organizations' agility and, in turn, foster the achievement of so-called market capitalization and operational agility (Lu and Ramamurthy, 2011). Since a firm capable to achieve market capitalization and operational agility may identify opportunities in the market and adjust internal production capacity to follow the demand, BDA-capable BPMS may therefore increase ambidextrous organizations' exploration and exploitation capabilities (Nazir and Pinsonneault, 2012).

In this way, this research contributes to the stream of literature on BPMS (Wamba and Mishra, 2017) by providing insight into the outcomes of integrating BDA within BPMS. Moreover, it additionally contributes to the stream of literature on ambidextrous organizations' agility (O'Reilly and Tushman, 2013). Specifically, the principal contribution to this first stream of literature concerns better identifying the characteristics and the potential of BDA-capable BPMS, which are both topics that have been rather neglected in existing literature on BPMS, with a few exceptions (Mishra *et al.*, 2017; Motamarri *et al.*, 2017). Instead, this research has enriched literature on ambidextrous organizations' agility by providing further insights on the importance of BDA-capable BPMS in increasing dynamism and achieving market capitalization and operational adjustment agility (Lu and Ramamurthy, 2011). Thus, such BPMS may increase exploration and exploitation capabilities of ambidextrous organizations (Gao, 2013; Leonhardt *et al.*, 2017).

4.2 Implications for practitioners: implementing BDA-capable BPMS in ambidextrous organizations

In spite of the potential of BDA-capable BPMS in increasing ambidextrous organizations agility, some challenges may emerge during the implementation of such BPMS. It is therefore first necessary to comment on the technical challenges associated with BDA-capable BPMS in order to better appreciate the importance of coupling ambidextrous organizations' agility with BDA-capable BPMS. It is crucial, indeed, to have a full understanding of where the big data comes from in order to focalize information systems' role in today's organizations.

In case of big data, the analytical architecture, underlying data processes, procedures, tools and methods are different when compared to small data (going from a data warehouse to data lake for big data) (LaValle *et al.*, 2011). For example, we speak of the Not Only SQL data model, schema-less data retrieval real-time data action and horizontally scaled data system architecture for big data, as opposed to relational data model, schema data retrieval, data-at-rest and monolithic systems with vertical scaling for small data (Vossen, 2013; Rothberg and Erickson, 2017). With all these differences, it is a significant challenge to manage big data (IBM, 2012). One of the mistakes that many organizations make when adopting BDA-capable BPMS to pursue agility is to consider BDA as an architectural design, wherein the database is seen as a static repository and schemas are usually fixed and unable to bring any dynamic dimension (Yin and Kaynak, 2015). To find the best possible architectural approach, first, we have to understand how the big data is deployed. Usually, it starts with implementing an engine for big data processing (e.g. Hadoop, Apache Spark, etc.) with the necessary physical infrastructure, which includes the complex configuration of servers, storage and other components necessary to run and process the big data center. With more data, more resources (e.g. hardware) will be needed, meaning that

organizations will have to go through another iterative process of buying more hardware, and this process takes time. In order to speed up this process, we are witnessing a trend where organizations are turning to cloud providers (e.g. Amazon AWS) which give them an agile infrastructure in which resources are pulled in or out based on the demand (Lu and Ramamurthy, 2011). This approach is sufficient when it comes to bringing agility to organizations from an infrastructure standpoint.

Thus, ambidextrous organization's agility, in order to be successfully integrated with big data, has to deliver on several other premises. The debate on this relationship between architectural design and agility is still ongoing (Chen *et al.*, 2016). As outlined above, the BDA infrastructure's build processes represent an "up-front" approach where everything must be ready before the data are analyzed, which rather contradicts the meaning of agility itself (Bellomo *et al.*, 2015). Gao (2013) and Chen *et al.* (2016) demonstrated the alignment between the two worlds: agility, actually, supports the iterative nature of big data. One possible way in implementing and following this iterative nature is to build systems that can be easily iterated, modified, adapted or replaced, and this is coherent with the adaptability of the majority of BDA-capable BPMS. A cultural shift is an important consideration, as organizations looking to combine agility with the big data will need to look beyond their existing state of mind, and aim for exploration and change. This will bring flexibility related to agility, which means temporal and financial savings for the organization.

We can speak of "big data culture" where the entire organization has to work on adapting their employees' mind-set to the new approach (Tallon and Pinsonneault, 2011; Caniëls *et al.*, 2017). For example, for a bank to remain competitive and launch new services and products, it is necessary to adopt new models of working by implementing and launching digital initiatives before the competition. The only way to be faster than the traditional implementation is to implement the new technology infrastructure with a data lake containing structured and unstructured data (e.g. Twitter data) (Davenport *et al.*, 2012; Caputo *et al.*, 2016; Bumblauskas *et al.*, 2017; Santoro *et al.*, 2017). The business alignment between the IT department and the business team is vital in creating systems that respond to specific user requests and needs (Gao, 2013; Ferraris *et al.*, 2017b), and the entire process has to be iterative enough so time is not lost between different implementations and trials.

In spite of such difficulties, however, an ambidextrous organization would be able to implement such systems, subsequently providing managers with a real-time snapshot of consumer's (internal or external) data, giving a clear competitive advantage to agile organizations as it enables them to get real-time information about any service, product or procedure an organization wants to improve or implement. This is coherent with the expected outcomes hypothesized (namely, market capitalization and operational adjustment agility) (Lu and Ramamurthy, 2011; Zollo *et al.*, 2016; Wamba and Mishra, 2017). Hence, well-designed, projected and implemented BDA-capable BPMS may allow ambidextrous organizations to increase their agility and to achieve market capitalization and operational adjustment agility. This is possible due to their dynamic capability to extract information from such systems (Chen *et al.*, 2014).

Briefly, then, the marriage between ambidextrous organization and BDA-capable BPMS will be successful as long as organizations allow for cultural shifts and conduct appropriate implementation steps that will provide dynamic capabilities of big data (Tallon and Pinsonneault, 2011; Wamba and Mishra, 2017).

5. Conclusions, limitations and suggestions for future research

The aim of the present research was to identify the effect of BDA-capable BPMS on ambidextrous organizations' agility. The results highlight the role of such systems in increasing dynamism and reactiveness to the environmental changes of organizations and, consequently, organizational agility (Zain *et al.*, 2005). Moreover, the achievement of market

capitalization and operational adjustment agility have emerged as the principal results of the implementation of such BPM systems (Lu and Ramamurthy, 2011). Increased exploration and exploitation capabilities may also be considered related to implementing BDA-capable BPMS within ambidextrous organizations.

Thus, the proposed conceptual framework was applied to consumer-goods companies in order to test its validity and robustness. The qualitative results suggested that the theory and practice are aligned and, therefore, we can consider the prosed model valid and applicable to a wider set of organizations. In this vein, albeit our results are not fully generalizable, the present research has contributed to both theory and practice.

Regarding the first, this paper can be seen to expand academic literature on ambidextrous organizations and business process management (Wamba and Mishra, 2017). In particular, we have merged the principle of organizational agility with ambidextrous organization literature, showing the ways in which an ambidextrous organization needs to be agile in the era of big data.

With regard to practical implications, this research shows the importance of BDA-capable BPMS in fostering ambidextrous organization's agility, especially for companies – like consumer-goods companies – which are constantly dealing with a large amount of data. Moreover, we have provided a framework for managers which is suitable for diagnosing organizational agility issues within a company and its connection with data-related issues.

However, this research is limited in some aspects. In particular, its main limitation relates to the fact that the conceptual framework has been developed on findings from existing studies coming from a different set of industries. We tried to overcome this critical aspect by adding empirical validation to our findings, but still a wider testing of the present framework is need.

In fact, we would advise future researchers to better examine the phenomenon with in-depth case studies from exemplary organizations, comparing different industries and different markets. Moreover, a quantitative analysis is needed to provide information on the importance of the implication of BDA in BPM, and to try to quantify the outcomes in terms of effectiveness or efficiency. In particular, a clear connection between organizational agility, ambidextrous organization and performance should be established.

Finally, we wish to stress that the theoretical development of this present stream of research will benefit from continuous updating due to the ever-changing environment generated by the Big Data era.

References

Barras, R. (1986), "Towards a theory of innovation in services", *Research Policy*, Vol. 15 No. 4, pp. 161-173.

Bellomo, S., Gorton, I. and Kazman, R. (2015), "Toward agile architecture: insights from 15 years of ATAM data", *IEEE Software*, Vol. 32 No. 5, pp. 38-45.

Bresciani, S., Ferraris, A. and Del Giudice, M. (2017), "The management of organizational ambidexterity through alliances in a new context of analysis: internet of things (IoT) smart city projects", *Technological Forecasting and Social Change*, available at: https://doi.org/10.1016/j.techfore.2017.03.002

Bumblauskas, D., Nold, H., Bumblauskas, P. and Igou, A. (2017), "Big data analytics: transforming data to action", *Business Process Management Journal*, Vol. 23 No. 3, pp. 703-720.

Campos, E.B. and Sanchez, P.S. (2003), "Knowledge management in the emerging strategic business process: information, complexity and imagination", *Journal of Knowledge Management*, Vol. 7 No. 2, pp. 5-17.

Caniëls, M.C., Neghina, C. and Schaetsaert, N. (2017), "Ambidexterity of employees: the role of empowerment and knowledge sharing", *Journal of Knowledge Management*, Vol. 21 No. 5, pp. 1098-1119.

Caputo, A., Marzi, G. and Pellegrini, M.M. (2016), "The internet of things in manufacturing innovation processes: development and application of a conceptual framework", *Business Process Management Journal*, Vol. 22 No. 2, pp. 341-358.

Carayannis, E.G., Grigoroudis, E., Del Giudice, M., Della Peruta, M.R. and Sindakis, S. (2017), "An exploration of contemporary organizational artifacts and routines in a sustainable excellence context", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 35-56.

Cegarra-Navarro, J.G., Wensley, A., Jimenez-Jimenez, D. and Sotos-Villarejo, A. (2017), "Linking procedural memory with organizational learning through knowledge corridors", *Journal of Knowledge Management*, Vol. 21 No. 6, pp. 1503-1522, available at: https://doi.org/10.1108/JKM-01-2017-0018

Chen, H.M., Kazman, R. and Haziyev, S. (2016), "Agile big data analytics for web-based systems: an architecture-centric approach", *IEEE Transactions on Big Data*, Vol. 2 No. 3, pp. 234-248.

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L. and Chow, W.S. (2014), "IT capability and organizational performance: the roles of business process agility and environmental factors", *European Journal of Information Systems*, Vol. 23 No. 3, pp. 326-342.

Chui, M. and Fleming, T. (2011), "Inside P & G's digital revolution", *McKinsey Quarterly*, Vol. 111 No. 1, pp. 59-68.

Davenport, T.H. (2014), "How strategists use 'big data' to support internal business decisions, discovery and production", *Strategy & Leadership*, Vol. 42 No. 4, pp. 45-50.

Davenport, T.H., Barth, P. and Bean, R. (2012), "How big data is different", *MIT Sloan Management Review*, Vol. 54 No. 1, pp. 43-46.

De Mauro, A., Greco, M., Grimaldi, M. and Ritala, P. (2017), "Human resources for big data professions: a systematic classification of job roles and required skill sets", *Information Processing & Management*, available at: https://doi.org/10.1016/j.ipm.2017.05.004

Del Giudice, M. (2016), "Discovering the internet of things (IoT) within the business process management: a literature review on technological revitalization", *Business Process Management Journal*, Vol. 22 No. 2, pp. 263-270.

Del Giudice, M. and Della Peruta, M.R. (2016), "The impact of IT-based knowledge management systems on internal venturing and innovation: a structural equation modelling approach to corporate performance", *Journal of Knowledge Management*, Vol. 20 No. 3, pp. 484-498.

Del Giudice, M. and Straub, D. (2011), "Editor's comments: IT and entrepreneurism: an on-again, off-again love affair or a marriage?", *MIS Quarterly*, Vol. 35 No. 4, pp. iii-viii.

Del Giudice, M., Caputo, F. and Evangelista, F. (2016), "How are decision systems changing? The contribution of social media to the management of decisional liquefaction", *Journal of Decision Systems*, Vol. 25 No. 3, pp. 214-226.

Deloitte (2017), "Fast moving consumer goods analytics framework: point of view", Deloitte University Press, Consumer product trends Navigating 2020, New York, NY, available at: www2.deloitte.com/content/dam/Deloitte/nl/Documents/consumer-business/deloitte-nl-cip-fmcg-analytics-framework.pdf (accessed September 15, 2017).

Dubey, R., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Luo, Z., Wamba, S.F. and Roubaud, D. (2017), "Can big data and predictive analytics improve social and environmental sustainability?", *Technological Forecasting and Social Change*, available at: https://doi.org/10.1016/j.techfore.2017.06.020

Duncan, R.B. (1976), "The ambidextrous organization: designing dual structures for innovation", *The Management of Organization*, Vol. 1 No. 1, pp. 167-188.

Ferraris, A., Erhardt, N. and Bresciani, S. (2017a), "Ambidextrous work in smart city project alliances: unpacking the role of human resource management systems", *International Journal of Human Resource Management*, doi: 10.1080/09585192.2017.1291530.

Ferraris, A., Santoro, G. and Dezi, L. (2017b), "How MNC's subsidiaries may improve their innovative performance? The role of external sources and knowledge management capabilities", *Journal of Knowledge Management*, Vol. 21 No. 3, pp. 540-552.

Gandomi, A. and Haider, M. (2015), "Beyond the hype: big data concepts, methods, and analytics", *International Journal of Information Management*, Vol. 35 No. 2, pp. 137-144.

Gao, X. (2013), "Towards the next generation intelligent BPM – in the era of big data", in Daniel, F., Wang, J. and Weber, B. (Eds), *Business Process Management: Lecture Notes in Computer Science*, Vol. 8094, pp. 4-9, Springer International Publishing, Berlin.

Gibson, C.B. and Birkinshaw, J. (2004), "The antecedents, consequences, and mediating role of organizational ambidexterity", *Academy of Management Journal*, Vol. 47 No. 2, pp. 209-226.

Gothelf, J. (2014), "Bring agile to the whole organization", *Harvard Business Review*, available at: https://hbr.org/2014/11/bring-agile-to-the-whole-organization (accessed July 1, 2017).

Guisado-González, M., González-Blanco, J. and Coca-Pérez, J.L. (2017), "Analyzing the relationship between exploration, exploitation and organizational innovation", *Journal of Knowledge Management*, Vol. 21 No. 5, pp. 1142-1162.

Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B. and Akter, S. (2017), "Big data and predictive analytics for supply chain and organizational performance", *Journal of Business Research*, Vol. 70 No. 1, pp. 308-317.

Hahn, T., Pinkse, J., Preuss, L. and Figge, F. (2016), "Ambidexterity for corporate social performance", *Organization Studies*, Vol. 37 No. 2, pp. 213-235.

Hill, J.B. and Schulte, R.W. (2011), "BPM suites evolve into intelligent BPM suites", Gartner, Stamford, CT.

Hofacker, C.F., Malthouse, E.C. and Sultan, F. (2016), "Big data and consumer behavior: imminent opportunities", *Journal of Consumer Marketing*, Vol. 33 No. 2, pp. 89-97.

IBM (2012), "What is big data?", IBM Corporate Website, available at: www-01.ibm.com/software/data/bigdata/ (accessed May 3, 2017).

Junni, P., Sarala, R.M., Taras, V. and Tarba, S.Y. (2013), "Organizational ambidexterity and performance: a meta-analysis", *The Academy of Management Perspectives*, Vol. 27 No. 4, pp. 299-312.

Kalpič, B. and Bernus, P. (2006), "Business process modeling through the knowledge management perspective", *Journal of Knowledge Management*, Vol. 10 No. 3, pp. 40-56.

Khan, Z. and Vorley, T. (2017), "Big data text analytics: an enabler of knowledge management", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 18-34.

Kim, H.M. and Ramkaran, R. (2004), "Best practices in e-business process management: extending a re-engineering framework", *Business Process Management Journal*, Vol. 10 No. 1, pp. 27-43.

Kortmann, S., Gelhard, C., Zimmermann, C. and Piller, F.T. (2014), "Linking strategic flexibility and operational efficiency: the mediating role of ambidextrous operational capabilities", *Journal of Operations Management*, Vol. 7 Nos 7-8, pp. 475-490.

LaValle, S., Lesser, E., Shockley, R., Hopkins, M.S. and Kruschwitz, N. (2011), "Big data, analytics and the path from insights to value", *MIT Sloan Management Review*, Vol. 52 No. 2, pp. 21-32.

Lee, O.K., Sambamurthy, V., Lim, K.H. and Wei, K.K. (2015), "How does IT ambidexterity impact organizational agility?", *Information Systems Research*, Vol. 26 No. 2, pp. 398-417.

Leonhardt, D., Haffke, I., Kranz, J. and Benlian, A. (2017), "Reinventing the it function: the role of it agility and it ambidexterity in supporting digital business transformation", *Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, June 5–10*, pp. 968-984, available at: http://aisel.aisnet.org/ecis2017_rp/63 (accessed October 14, 2017).

Lin, Z., Yang, H. and Demirkan, I. (2007), "The performance consequences of ambidexterity in strategic alliance formations: empirical investigation and computational theorizing", *Management Science*, Vol. 53 No. 10, pp. 1645-1658.

Lock Lee, L. (2005), "Balancing business process with business practice for organizational advantage", *Journal of Knowledge Management*, Vol. 9 No. 1, pp. 29-41.

Lopez-Nicolas, C. and Soto-Acosta, P. (2010), "Analysing ICT adoption and use effects on knowledge creation: an empirical investigation in SMEs", *International Journal of Information Management*, Vol. 30 No. 6, pp. 521-528.

Lu, Y. and Ramamurthy, K. (2011), "Understanding the link between information technology capability and organizational agility: an empirical examination", *MIS Quarterly*, Vol. 35 No. 4, pp. 931-954.

Lubatkin, M.H., Simsek, Z., Ling, Y. and Veiga, J.F. (2006), "Ambidexterity and performance in small-to medium-sized firms: the pivotal role of top management team behavioral integration", *Journal of Management*, Vol. 32 No. 5, pp. 646-672.

Lugmayr, A., Stockleben, B., Scheib, C. and Mailaparampil, M.A. (2017), "Cognitive big data: survey and review on big data research and its implications: what is really 'new' in big data?", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 197-212.

McAfee, A. and Brynjolfsson, E. (2012), "Big data: the management revolution", *Harvard Business Review*, Vol. 90 No. 10, pp. 60-68.

McAfee, A., Brynjolfsson, E., Davenport, T.H., Patil, D.J. and Barton, D. (2012), "Big data: the management revolution", *Harvard Business Review*, Vol. 90 No. 10, pp. 60-68.

Maier, R. and Remus, U. (2003), "Implementing process-oriented knowledge management strategies", *Journal of Knowledge Management*, Vol. 7 No. 4, pp. 62-74.

Marzi, G., Caputo, A. and Dabic, M. (2017), "Management lessons from Italy: a bibliometric analysis of top Italian based scholars and studies published from 1985 to 2015", *International Journal of Critical Accounting* (forthcoming).

Marzi, G., Dabić, M., Daim, T. and Garces, E. (2017), "Product and process innovation in manufacturing firms: a 30-year bibliometric analysis", *Scientometrics*, Vol. 113 No. 32, pp. 673-704.

Marzi, G., Zollo, L., Boccardi, A. and Ciappei, C. (2017), "Additive manufacturing in SMEs: empirical evidences from Italy", *International Journal of Innovation and Technology Management*, Forthcoming.

Mishra, D., Luo, Z., Jiang, S., Papadopoulos, T. and Dubey, R. (2017), "A bibliographic study on big data: concepts, trends and challenges", *Business Process Management Journal*, Vol. 23 No. 3, pp. 555-573.

Motamarri, S., Akter, S. and Yanamandram, V. (2017), "Does big data analytics influence frontline employees in services marketing?", *Business Process Management Journal*, Vol. 23 No. 3, pp. 623-644.

Nazir, S. and Pinsonneault, A. (2012), "IT and firm agility: an electronic integration perspective", *Journal of the Association for Information Systems*, Vol. 13 No. 3, pp. 150-171.

Niehaves, B. and Plattfaut, R. (2011), "Collaborative business process management: status quo and quo vadis", *Business Process Management Journal*, Vol. 17 No. 3, pp. 384-402.

O'Reilly, C.A. and Tushman, M.L. (2008), "Ambidexterity as a dynamic capability: resolving the innovator's dilemma", *Research in Organizational Behavior*, Vol. 28, pp. 185-206.

O'Reilly, C.A. and Tushman, M.L. (2013), "Organizational ambidexterity: past, present, and future", *Academy of Management Perspectives*, Vol. 27 No. 4, pp. 324-338.

Overby, E., Bharadwaj, A. and Sambamurthy, V. (2006), "Enterprise agility and the enabling role of information technology", *European Journal of Information Systems*, Vol. 15 No. 2, pp. 120-131.

Pauleen, D.J. and Wang, W.Y. (2017), "Does big data mean big knowledge? KM perspectives on big data and analytics", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 1-6.

Porter, M.E. (1974), "Consumer behavior, retailer power and market performance in consumer goods industries", *The Review of Economics and Statistics*, Vol. 56 No. 4, pp. 419-436.

Porter, M.E. (1980), *Competitive Strategy*, Free Press, New York, NY.

Raisch, S., Birkinshaw, J., Probst, G. and Tushman, M.L. (2009), "Organizational ambidexterity: balancing exploitation and exploration for sustained performance", *Organization Science*, Vol. 20 No. 4, pp. 685-695.

Rialti, R., Zollo, L., Caliandro, A. and Ciappei, C. (2016), "Social media strategies to protect brand image and corporate reputation in the digital era: a digital investigation of the Eni vs. Report case", *Mercati & Competitività*, No. 4, pp. 65-84.

Rialti, R., Zollo, L., Pellegrini, M.M. and Ciappei, C. (2017), "Exploring the antecedents of brand loyalty and electronic word of mouth in social-media-based brand communities: do gender differences matter?", *Journal of Global Marketing*, Vol. 30 No. 3, pp. 147-160.

Roberts, N. and Grover, V. (2012), "Leveraging information technology infrastructure to facilitate a firm's consumer agility and competitive activity: an empirical investigation", *Journal of Management Information Systems*, Vol. 28 No. 4, pp. 231-270.

Rothberg, H.N. and Erickson, G.S. (2017), "Big data systems: knowledge transfer or intelligence insights?", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 92-112.

Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003), "Shaping agility through digital options: reconceptualising the role of information technology in contemporary firms", *MIS Quarterly*, Vol. 27 No. 2, pp. 237-26.

Santoro, G., Vrontis, D., Thrassou, A. and Dezi, L. (2017), "The internet of things: building a knowledge management system for open innovation and knowledge management capacity", *Technological Forecasting and Social Change*, available at: https://doi.org/10.1016/j.techfore.2017.02.034

SAS (2016), Big Data: What is and Why it matters, SAS corporate website, available at: www.sas.com/en_us/insights/big-data/what-is-big-data.html (accessed June 15, 2017).

Scuotto, V., Ferraris, A. and Bresciani, S. (2016), "Internet of things: applications and challenges in smart cities: a case study of IBM smart city projects", *Business Process Management Journal*, Vol. 22 No. 2, pp. 357-367.

Scuotto, V., Santoro, G., Bresciani, S. and Del Giudice, M. (2017), "Shifting intra-and inter-organizational innovation processes towards digital business: an empirical analysis of SMEs", *Creativity and Innovation Management*, Vol. 26 No. 3, pp. 247-255.

Sivarajah, U., Kamal, M.M., Irani, Z. and Weerakkody, V. (2017), "Critical analysis of big data challenges and analytical methods", *Journal of Business Research*, Vol. 70 No. 1, pp. 263-286.

Tallon, P.P. and Pinsonneault, A. (2011), "Competing perspectives on the link between strategic information technology alignment and organizational agility: insights from a mediation model", *MIS Quarterly*, Vol. 35 No. 2, pp. 463-486.

Tushman, M.L. and O'Reilly, C.A. (1996), "The ambidextrous organizations: managing evolutionary and revolutionary change", *California Management Review*, Vol. 38 No. 4, pp. 8-30.

Vera-Baquero, A., Colomo Palacios, R., Stantchev, V. and Molloy, O. (2015), "Leveraging big-data for business process analytics", *The Learning Organization*, Vol. 22 No. 4, pp. 215-228.

Vossen, G. (2013), "Big data as the new enabler in business and other intelligence", *Vietnam Journal of Computer Science*, Vol. 1 No. 1, pp. 3-14.

Vrontis, D., Thrassou, A., Santoro, G. and Papa, A. (2017), "Ambidexterity, external knowledge and performance in knowledge-intensive firms", *The Journal of Technology Transfer*, Vol. 42 No. 2, pp. 374-388.

Wamba, S.F. and Mishra, D. (2017), "Big data integration with business processes: a literature review", *Business Process Management Journal*, Vol. 23 No. 3, pp. 477-492.

Wamba, S.F., Akter, S., Edwards, A., Chopin, G. and Gnanzou, D. (2015), "How 'big data' can make big impact: findings from a systematic review and a longitudinal case study", *International Journal of Production Economics*, Vol. 165, pp. 234-246.

Wamba, S.F., Gunasekaran, A., Akter, S., Ren, S.J.F., Dubey, R. and Childe, S.J. (2017), "Big data analytics and firm performance: effects of dynamic capabilities", *Journal of Business Research*, Vol. 70 No. 1, pp. 356-365.

Wei, Z., Yi, Y. and Guo, H. (2014), "Organizational learning ambidexterity, strategic flexibility, and new product development", *Journal of Product Innovation Management*, Vol. 31 No. 4, pp. 832-847.

Wu, I.L. and Chen, J.L. (2014), "Knowledge management driven firm performance: the roles of business process capabilities and organizational learning", *Journal of Knowledge Management*, Vol. 18 No. 6, pp. 1141-1164.

Yin, S. and Kaynak, O. (2015), "Big data for modern industry: challenges and trends [point of view]", *Proceedings of the IEEE*, Vol. 103 No. 2, pp. 143-146.

Zain, M., Rose, R.C., Abdullah, I. and Masrom, M. (2005), "The relationship between information technology acceptance and organizational agility in Malaysia", *Information & Management*, Vol. 42 No. 6, pp. 829-839.

Zollo, L., Marzi, G., Boccardi, A. and Ciappei, C. (2016), "Gli effetti della Stampa 3D sulla competitività aziendale: Il caso delle imprese orafe del distretto di Arezzo", *Piccola Impresa/Small Business*, No. 2, pp. 80-100.

Zollo, L., Marzi, G., Boccardi, A. and Surchi, M. (2015), "How to match technological and social innovation: insights from the biomedical 3D printing industry", *International Journal of Transitions and Innovation Systems*, Vol. 4 Nos 1-2, pp. 80-95.

Corresponding author
Riccardo Rialti can be contacted at: riccardo.rialti@gmail.com