The relationship between intellectual capital and big data: a review

Federica De Santis and Claudia Presti
Dipartimento di Economia e Management, University of Pisa, Pisa, Italy

Abstract

Purpose – This paper aims to give an integrated framework for analysing the main opportunities and threats related to the exploitation of Big Data (BD) technologies within intellectual capital (IC) management.

Design/methodology/approach – By means of a structured literature review (SLR) of the extant literature on BD and IC, the study identified distinctive opportunities and challenges of BD technologies and related them to the traditional dimensions of IC.

Findings – The advent of BD has not radically changed the risks and opportunities of IC management already highlighted in previous literature. However, it has significantly amplified their magnitude and the speed with which they manifest themselves. Thus, a revision of the traditional managerial solutions needed to face them is required.

Research limitations/implications – The developed framework can contribute to academic discourse on BD and IC as a starting point to understanding how BD can be turned into intangible assets from a value creation perspective.

Practical implications – The framework can also represent a useful decision-making tool for practitioners in identifying and evaluating the main opportunities and threats of an investment in BD technologies for IC management.

Originality/value – The paper responds to the call for more research on the integration of BD discourse in the fourth stage of IC research. It intends to improve this understanding of how BD technologies can be exploited to create value from an IC perspective, focusing not only on the potential of BD for creating value but also on the challenges that it poses to organizations.

Keywords Big data, Fourth stage ICR, Intellectual capital management

Paper type Research paper

Introduction

The rise of the knowledge economy and the currently increasing social connectivity (Edvinsson, 2013) have had a marked impact on intellectual capital (IC) research and on IC perspectives (Borin and Donato, 2015). Right now, scholars are in the so-called fourth stage of IC research, which goes beyond the traditional approach, analysing how IC dimensions interact and contribute to the value creation process within organizations and considering the social dimension of IC (Secundo et al., 2017). It can therefore be argued that currently there is a shift in the focus of IC research, whereby IC expands its boundaries to include other forms of value, beyond just monetary wealth (Dumay, 2016).

The authors are grateful to the guest editor and the two anonymous reviewers for their thoughtful comments and suggestions. They further greatly appreciate the comments of the participants at the 13th EIASM Workshop on Intangibles and Intellectual Capital.
Big Data (BD) is one of the most representative paradigms of the contemporary knowledge economy (Secundo et al., 2017) as it represents a large volume of complex data (structured and unstructured) from a variety of sources (internal and external) that can support value delivery, performance measurement and establishing competitive advantage (Fredriksson, 2015; Wamba et al., 2015). In the so-called knowledge era, data and information can integrate the intangible assets mix, as potentially valuable intangibles can be situated both inside and outside an organization (Borin and Donato, 2015). BD can therefore significantly contribute to creating new forms of value (Brown, 2014) and can represent relevant input by shifting the focus of IC from within to outside the organization.

Although some scholars have started to recognize the opportunity of integrating the BD discourse in the fourth stage of IC research (Erickson and Rothberg, 2014; Fredriksson, 2015; Secundo et al., 2017), one could argue that research on this topic is still in its early stages. Further, although most of the extant literature on BD focuses on its value creating potential, some scholars and practitioners have pointed out that for a BD investment to succeed, firms should pay proper attention to the challenges of implementing BD technologies (Erevelles et al., 2016). So, it becomes important to gain a deeper understanding and an integrated view of how introducing BD technologies can affect IC management.

By linking the opportunities and challenges associated with the adoption of BD technologies to the traditional dimensions of IC (i.e. human, structural and relational capital), this paper aims to propose an integrated framework that systematically identifies and classifies the main threats and opportunities related to exploiting BD technologies from an IC management perspective. The proposed framework is developed on the basis of the results of a structured literature review (SRL), a rigorous and minimally biased approach to conducting an insightful and critical analysis of the extant literature on the topic under investigation (Tranfield et al., 2003).

The literature analysis and the proposed interpretive framework suggest that the advent of BD has determined relevant opportunities for IC management, provided that organizations investing in such a technology are willing to face and appropriately deal with the related challenges. Second, the analysed literature emphasizes that these challenges do not significantly differ from many of the risks and opportunities already highlighted in previous IC management studies. At the same time, the BD era has significantly amplified the magnitude of these threats and the accelerated tempo at which they appear. To overcome the mentioned risks and to best exploit the benefits related to BD requires us to revise the traditional managerial solutions. The research reported on here can make a valuable contribution to the fourth stage of IC research and, by providing some preliminary insights into how, taking a value creation perspective, BD and the related technologies can be turned into intangible assets. Moreover, the proposed interpretive framework could be a useful decision-making tool for organizations that are investing in BD technologies, assisting them to map and evaluate the likelihood and the extent of the identified threats and opportunities, so that they can plan and apply a proper management strategy.

This paper is structured as follows: The following section provides first insights regarding the opportunity to integrate the BD discourse into the IC domain. Then, the next section explains the methodological approach taken in this study. The proposed interpretive framework is presented and some valuable insights are traced next. Thereafter, the paper summarizes the most relevant findings gained by means of the conducted analysis, and the last section gives the implications of the study, its limitations and mentions possible opportunities for further research.
Intellectual capital research in the age of Big Data

Based on the idea that intangible assets constitute a key source of competitive advantage, the value such assets bring to organizations has long been recognized (Drucker, 1994). Numerous scholars following to the resource-based theory of the firm have highlighted the crucial role knowledge plays as the source of unique, sustainable, marketplace advantage (Erickson and Rothberg, 2014). IC is a multifaceted and heterogeneous concept which is differently defined by different scholars. For the purpose of the present study, IC is defined as “the sum of everything everybody in a company knows that gives it a competitive edge”. Then IC consists of “intellectual material, knowledge, experience, intellectual property and information that can be put to use to create value” (Stewart, 1997; Dumay, 2016, p. 169).

Also, providing a definition of “value” is a complex issue on which there is no consensus. According to Dumay (2016), the concept of value derives from the combination of four different perspectives, namely, monetary value, utility value, social value and sustainable value. Monetary value represents the first and foremost perspective, which is essential for all forms of value creation. Nonetheless, it does not represent the primary long-term objective of an entity. Utility value, contrastively, relates to the perceived usefulness of a company’s product and services, while social value relates to the benefits an organization provides to society in general. Finally, the fourth value perspective, i.e. sustainable value, is related to the organization’s ability to “meet the needs of the present without compromising the ability of future generations to meet their own needs”. According to Dumay (2013, 2016), the concept of sustainable value is the cornerstone of the fourth stage of IC research.

In recent decades, scholars and practitioners have analysed IC taking different approaches, developing various concepts, methods and tools to measure, manage and report on IC (Giuliani, 2015). Currently, scholars are moving towards the so-called fourth stage of IC research, adopting a more performative approach with the aim of understanding IC “in action” (Dumay and Garanina, 2013, p. 17). In other words, academics are seeking to understand “how IC works in organizations, how it manifests itself, and how people, processes and relationships are mobilized in relation to it” (Chiucchi and Dumay, 2015, p. 306). In doing so, a broader view of IC is adopted, and the research focus is shifting from within to outside of the organization (Secundo et al., 2017). The concept of value creation, indeed, is expanding beyond monetary value and organizational wealth into wider societal value (Dumay and Garanina, 2013).

The most compelling reasons for this shift in the focus of IC research can be outlined as follows:

First, value creation is increasingly a matter of organizations’ ability to manage knowledge (Secundo et al., 2017). Second, the rapid development in computing and information and communication technologies (ICT) and the exponential growth of the amount of available information (Vasarhelyi et al., 2015) due to the emergence of BD along with the related technologies have blurred the boundaries between internal and external knowledge assets that companies can leverage to gain a sustainable competitive advantage (Lerro et al., 2012). Data can indeed originate from either inside an organization or from a wider ecosystem in which the organization is embedded, as it can come from all company stakeholders, both from internal sources and from external ones. Data and information thus have the potential to integrate the intangible asset mix with items such as competitive intelligence, enterprise intelligence and decision effectiveness (Andreou et al., 2007).

BD is one of the most representative paradigms of the complexity and turbulence of the so-called knowledge era. It can significantly contribute to the creation of new forms of value (Brown, 2014), and so represents a strong basis for competition (Satell, 2014). Quite early on BD was defined as “high-volume, high-velocity and high-variety information assets that
demand cost-effective, innovative forms of information processing for enhanced insights and decision-making” (Gartner IT Glossary, 2018). This preliminary set of distinctive features gave rise to the so-called 3Vs framework (volume, velocity and variety) (Laney, 2001), to which scholars and practitioners, over time, have added other key features, such as data value, data veracity and data variability (Gandomi and Haider, 2015) to give a clearer and more intuitive definition of the multifaceted and ambiguous concept of BD.

BD, therefore, is highly relevant in moving the focus of IC from within to outside the organization, as it can potentially transform processes, alter corporate ecosystems and facilitate innovation (Brown et al., 2011). It stimulates the adoption of a new form of decision-making, as it determines a shift “from fitting data to preconceived theories of the marketplace, to using data to frame theories” (Erevelles et al., 2016, p. 897). In other words, BD is facilitating the emergence of new kinds of companies that adopt a data-driven business model in which the traditional relationship between data, information and knowledge is redesigned. Data have become the prime mover of organizational actions (Batra, 2014), and decision-making processes are no longer a function of hypothesis testing; rather they increasingly represent a process of predictive modelling (Tian, 2017).

BD can feed into creating knowledge on a broad perspective (Dumay, 2013) and into generating new opportunities for IC management (Secundo et al., 2017), thus becoming a new form of corporate asset. In such an environment, knowledge management plays a leading role in the adoption and governance of BD and analytics within the organization. It enables combining, sharing and facilitating the growth of organizational knowledge (Grant, 1996). By means of knowledge management firms are able to decide what data is required to manage the organization efficiently and effectively, and how this data should be processed and analysed to gain useful information for decision-making. Further, knowledge management can help firms in developing knowledge-based feedback loops that will enhance data collection and data analysis processes in response to the environmental changes (Pauleen and Wang, 2017).

To summarize, valuable intangible assets can be located both inside and outside the organization, as “capital in waiting” (Edvinsson, 2013). Thus, it is increasingly becoming a strategic task (Secundo et al., 2017) to create “a bridge between brains inside the organization, i.e. human capital (HC), and brains outside the organization, i.e. relational capital” (Borin and Donato, 2015, p. 286). Although some scholars have started to recognize opportunities for integrating the BD discourse with the fourth stage of IC research (Erickson and Rothberg, 2014; Fredriksson, 2015), the way in which organizations can exploit BD technologies to create value in an IC perspective, remains under-investigated. At present, one can argue that research on integrating opportunities and challenges of BD with IC management, is still in its infancy. Scholars and practitioners, moreover, are unanimous in assuming that information in the “knowledge society” constitutes a fundamental resource for companies’ success. Most of them assume that the increased volume of available data will bring gains in competitive advantage.

As yet it is still not clear what shadows and challenges BD actually brings to the organization, nor how they are weighted (Erevelles et al., 2016). To be successful firms certainly have to be able to harness the power of IT (Melville et al., 2004). This implies a clear understanding of new technologies, of their potential capabilities, as well as of the risks that BD and analytics can bring to the organization. However, there are only a very few publications dealing with how firms could handle these challenges. It is therefore important to provide an integrated view on how adopting BD technologies can impact the different dimensions of IC taking a value creation perspective both in terms of opportunities and of risks.
Design of the study
This study aims to give a clear understanding of the impact BD and analytics have on various IC dimensions, both in terms of opportunities and challenges (Pauleen and Wang, 2017), by providing different lenses through which the existing literature can be analysed. The authors started with the assumption that BD can potentially create new value and new opportunities for IC management. However, the process of turning BD into tangible or intangible assets that become IC is still largely under-investigated (Secundo et al., 2017), thus existing literature could not answer questions in this regard. Moreover, an investment in BD and the related technologies cannot be considered risk free. On the one hand, firms have to harness the power of such technologies. On the other, they must also clearly understand the challenges that such an investment poses to the organization (Erevelles et al., 2016).

The research question addressed with this study was as follows:

RQ1. What are the risks and the opportunities related to adopting BD technologies in the traditional IC dimensions taking a value creation perspective?

To answer this question, the authors decided to develop an interpretive framework within which to analyse relevant data and gain insight on the topic. The proposed framework is rooted in an SLR which is considered the best type of academic review for summarizing a particular issue and developing an insightful and critical analysis, as it gives the advantage of “standing on the shoulders of giants” (Massaro et al., 2016). New research contributes to developing knowledge only when it is connected to past research. Consequently, a new investigation has to take note of and assimilate previous studies (Light and Pillemer, 1984). Moreover, an SLR follows a rigid set of rules that ensures the replicability of the study.

Preliminarily analysis and search criteria in the structured literature review
To give a comprehensive view of the topic under investigation, the authors first investigated the “pioneering” definitions of BD and IC and their evolution over time. This phase was crucial for reaching a deep understanding of the peculiarities of the research fields under consideration, and it allowed the authors to identify the most suitable research criteria to select and analyse the most relevant contributions. Considering that BD as a research field has its foundations in practice rather than in academia, the SLR inevitably had to appraise contributions from both academic and professional realms. Further, as the BD debate is still in its early stages and literature on the topic is scarce, the authors had to broaden the boundaries of a traditional search (Massaro et al., 2016; De Villiers and Dumay, 2013). Consequently, the researchers extracted not only academic publications but also conference proceedings, book chapters and professional contributions. To guarantee their relevance, however, only peer-reviewed contributions were selected. Regarding the other search criteria, for language reasons, the analysis included only contributions written in English. Finally, considering that BD is a recent research field and that both IC and BD are cross-disciplinary topics, to identify as many contributions as possible on these themes, no time, space or subject filters were applied.

Concerning source type, there is no general rule that defines how many should be included in such a review; thus, the authors decided not to focus on a particular journal, but to use the search engines offered by Business Source Complete (EBSCO), Web of Science (WoS), Emerald, Elsevier, Wiley, Taylor & Francis and Google Scholar. These search engines, in fact, cover a wide array of publications, both general and specific, that carried reference to the IC and BD discourses. In addition, by including Google Scholar and EBSCO, it was possible to consider not only academic journals and book chapters but also seminal
work such as conference proceedings and scientific reports and professional contributions (Mikki, 2009).

To ensure consistency with the research purpose and with the keywords traditionally associated with the IC topic, the authors identified the following search terms: “intellectual capital”, “human capital”, “organizational capital”, “structural capital”, “relational capital”, “social capital” and “intellectual capital management”. Only papers that mentioned the term “Big Data” in their title, abstract or in the keywords along with one of the abovementioned search terms, each as a fixed phrase, were extracted. This avoided the risk of selecting too many irrelevant articles (Massaro et al., 2016). The number of contributions retrieved using the systematic search until May 2017, after eliminating duplicates, came to 68.

Cleaning phase and development of the framework

The retrieved contributions seem not to follow a uniform distribution pattern (Figure 1). Nonetheless, interpreting this result as confirmation that some IC dimensions have been entirely neglected by both academics and practitioners would be misleading. As the first literature search was based on the contribution’s title, abstract or keywords, the authors decided to proceed with a complete and deeper analysis of the extracted contributions. This second analytic step highlighted that certain IC dimensions, which did not necessarily appear in the titles or in the keywords, were sometimes referred to, at least indirectly, in other sections of the considered papers.

None of the used sources can be labelled as predominant as most of the results were duplicated. The relevance of a contribution could be guaranteed, in addition to the peer-review filter, by the cleaning phase, conducted according two criteria, namely, the number of total citations and pertinence to the investigated topic. The analysis of the retrieved contributions over time highlighted that we are dealing with an emerging issue (Figure 2); thus, as inclusion/exclusion criterion, total citations appeared to be more appropriate than citations per year. While academic contributions with no citations were removed from the final list of the analysed works, all the practitioners’ contributions were included. The motivation for this choice is twofold. First, professional publications, unlike the academic ones, do not follow the logic of citation. Second, when the logic of citation is not applicable, the relevance of professional contributions is partially balanced by the presence of a peer-review process.

In the last part of the cleaning phase, as no subject filters were applied during the search, the authors carefully analysed the contributions that survived the total citation criterion (Figure 3), avoiding the risk of including non-pertinent studies. Therefore, of the 68
contributions initially retrieved, only 39 (49 per cent research articles, 31 per cent professional contributions, 13 per cent conference proceedings, 7 per cent books) were taken into consideration for developing the framework. To identify and code the links between the traditional dimensions of IC and the opportunities and threats introduced by the adoption of BD technologies, the authors manually analysed the 39 final contributions in parallel. Manual coding, indeed, is advised to ensure the true sense of an expression, as often different words or sentences can be used to explain the same concept (Guthrie et al., 2012).

After reaching consensus on the analysis, the major opportunities and risks that the adoption of BD technologies bring to organizations were linked to the traditional dimensions of IC. The gained insights were systematized within an interpretive framework, which distinguished between the phases of BD collection and BD consumption (Table I). This distinction was proposed because of the significant difference between the phases of data collection and information extraction. As pointed out by Gandomi and Haider (2015, p. 140), “BD are worthless in a vacuum” as its potential value “is unlocked only when leveraged to drive decision-making”, i.e. when data are organized, classified and elaborated as to become relevant and significant information to increase the rationality of a decision-making process (Marchi, 1993).

Big Data from an intellectual capital management perspective: the proposed interpretive framework
In the knowledge era, information, ideas and “people data” represent crucial factors that can effectively affect the competitive position of an organization. Companies are
thus required to adopt “solutions and evidence-based decisions that derive from the ability to access, integrate, analyse, and deploy massive amounts of data” (Johnson, 2013). Beyond the debate about the impact BD has on organizations’ decision-making processes, i.e. whether it is revolutionary (Tian, 2017; Erevelles et al., 2016) or simply evolutionary (Huberty, 2015), organizations have to be aware that BD represents a valuable opportunity in the current marketplace that they should not miss. At the same time, however, they should confront BD opportunities wisely so as not to overlook the challenges in their ambition to join a trend.

When introducing BD and the related technologies within organizations, it is crucial that managers become aware of what the related opportunities and threats are likely to be. BD, indeed, considerably increases computational power and algorithmic accuracy in collecting, analysing and comparing large amounts of data, and so enabling the identification of patterns that guide decision-making. This has given rise to a widespread belief that large data sets can offer “higher forms of intelligence and knowledge that can generate previously impossible insights, with an aura of truth, objectivity and accuracy” (Boyd and Crawford, 2012, p. 663). It is evident that BD offers significant opportunities for IC management. Nonetheless, its value creation potential can only be exploited if the risks of investing in advanced technology are properly managed. Table I presents the interpretive framework developed to gain a better understanding of these opportunities and challenges, and it
distinguishes between those related to the various phases of data collection and data consumption.

**Human capital and Big Data**

Even when companies adopt BD and the related technologies, HC remains one of the most strategic assets of organizations, in which they should invest (Higgins, 2014). Nonetheless, as the world changes and its complexity keeps growing, HC and its management are also required to adapt to the new context and to evolve towards new ways of operating their firms. The availability of high-tech tools has “smarted up the HC management” and might be useful in redefining the role of the human resource (HR) profession, transforming it into a strategic business partner that is able to anticipate changes and to act as an agent of change (Johnson, 2013).

Analytics can significantly impact the talent acquisition task (Gould, 2015; Wright, 2017) that is increasingly becoming a marketing activity, in which “companies see ways they can burnish their brand and candidates are consumers that must be wooed” (O’Mahony, 2015). The so-called “talent management” activity of “finding, recruiting, developing, managing and retaining the right people with the right skills in the right jobs” (Johnson, 2013, p. 13) has always represented a critical aspect of HC management overall (Thakur, 2016). The increasing environmental complexity and the higher relevance of HC as a source of competitive advantage have increased the magnitude and the complexity of this challenge to manage talent. It appears, however, that technological advancements have made available new and more effective tools to assist companies with this issue (Turner and Kalman, 2014).

In a globalized and highly interconnected world, new hiring perspectives are emerging, which give firms the opportunity to source a suitable workforce from the widest possible talent pool. This is made easier by means of, e.g. social media, mobile technologies, video and machine learning (Thakur, 2017). At the same time, interested candidates can exploit the huge amount of easy-to-access information to make more informed decisions about who they want to work for. This also has the potential to assure higher commitment of employees to the selected company (O’Mahony, 2015). The mere existence of adequate technological solutions, however, is not sufficient per se, as companies:

Must be able to deploy the right strategies – which are increasingly digital – in recruiting the best talents from all over the world, as well as in effectively onboarding, developing and retaining them (Johnson, 2013, p. 12).

The real revolution associated with the advent of BD is not represented by the availability of new data on the workforce. For decades, companies have collected large amounts of information on their employees, but due to limited instruments, they were not able to achieve as much as the same data can currently deliver. Either the data were spread out across different unconnected programmes or there were no suitable algorithms to transform data into meaningful information. Currently, HR analytics software enables companies in collecting BD on their workforce and its performance and in transforming data into insightful recommendations on, e.g. developing a proper talent recruitment strategy to reach and maintain a competitive advantage (Vereckey, 2013). Workforce analytics offer managers and supervisors solutions to promptly gain a complete overview of the employees to better evaluate their performance and acknowledge their needs (Lingga et al., 2014). Further, it enables improved ways of exploiting the organization’s strengths, fixing problems associated with the workforce, supporting career development and training the workforce for key future positions (Wei et al., 2015; Howes, 2014).
Employee retention represents another key issue in HC management (Hausknecht et al., 2009). Consistent with prior research, employee turnover (or, alternatively, employee retention rate) has to be controlled to effectively manage an organization’s HC, as talented people represent a key source of a company’s competitive advantage (Sheridan, 1992). In the BD age, the issue of employee retention has not lost its relevance. To support this, companies can now apply a specialized algorithm to calculate systematically, and thus function as a “retention rate predictor”. These new tools take into account dozens of talent attributes and can infer, with a high degree of accuracy, the likelihood that an employee will stay with the organization in the next year. By adopting these tools companies could also understand their employees’ degree of commitment and their inclination to leave, which in turn can assist them in making informed decisions about their career development programmes and in avoiding talent loss (Vereckey, 2013).

BD technologies, however, facilitate more than an organization’s acquiring and retaining skilled people. They can also facilitate the entire decision-making process of the company, provided that business analytics skills are distributed among more than only “expert” level employees, but rather extend to all the company’s employees (Shah et al., 2012; Wamba et al., 2015). It can, therefore, be argued that training and educational activities are crucial for the success of a BD investment. Adopting BD related technologies, moreover, can significantly contribute to improving the learning processes within organizations. According to Higgins (2014), proper utilization of BD technologies initiates a beneficial learning cycle because training people throughout the organization encourages widespread understanding and adopting of analytics tools in the day-to-day activities, which allows employees at all levels to extract and analyse useful information for decision-making.

It has to be taken into account, however, that making BD trustworthy and understandable to all employees is one of the major challenges of a company planning to invest in such technology. To create value, employees have to rely on BD-based models, which necessitate a proper understanding of how they work. One way of addressing this challenge would be to ensure active and extended collaboration between the employees and the team that implements the new BD infrastructure, as well as active involvement of the top management. Another key success or failure determiner when a firm invests in analytics depends on the firm’s ability to engage technically and analytically skilled data scientists (Davenport and Patil, 2012) who are also well conversant in business and governance issues, i.e. are able “to talk the language of business” (Wamba et al., 2015). Here, however, there is a significant challenge in that the demand for graduates with business analytics competence is rapidly increasing, while the corresponding supply is not growing at the same rate (Davenport, 2014).

Another relevant issue that emerges from a systematic analysis of the literature is related to the adoption of BD technologies for aiding the decision-making process. Consistent with the theory of technology dominance, making a smart tool available to a novice decision maker can hold a high risk of overreliance on and overconfidence in analytics. Employees could become technology dependent, giving rise to laziness that is apparent in such reliance on the results of the instruments that their trustworthiness is not even questioned. Further, as the opportunities offered by technology advancement increase, a growing effect of diminishing skills is seen (Arnold and Sutton, 1998).

Finally, against the assumption that BD potentially has endless benefits, we note that there are also risks to the companies seeking to unlock its potential, as well as to the individuals or businesses whose information is now continuously being collected, combined, analysed, disclosed and acted upon (Navetta, 2014, p. 1). Privacy issues constitute one of the most significant challenges when BD technologies are introduced in organizations. Such
difficulties relate not only to the HC dimension but also much more widely, they are evident across all the considered IC dimensions, impacting remarkably on the investment’s effectiveness and success. In this respect, companies have to ensure that information is handled securely enough not to be perceived as improperly invading privacy (Boyd and Crawford, 2012).

Companies, therefore, need to analyse and address the potential limitations and legal risks associated with the collection, analysis and use of BD and the insights derived from it. To do so, the so-called “data subjects” have to be made aware of how their personal information can be used, and to whom such information will be disclosed. However, due to the complexity of BD ecosystems and to the practical limitations of written privacy policies, it is quite difficult to raise data subjects’ awareness properly (Navetta, 2014). Data de-identification (or anonymization) and de-sensitization by means of data grouping and aggregation could offer a suitable solution in mitigating privacy concerns (McGuire and Ladd, 2014). Companies, however, must carefully take into account that if de-identification is not properly done, re-identifying individuals in an anonymized data set could be possible, and then incur legal liabilities (Navetta, 2014).

Structural capital and Big Data
Structural capital (SC) can be defined as the complex sum of all the non-human constituents of organizational knowledge that arises from processes and organizational learning (Bontis, 1998). It includes databases, organizational charts, process manuals, strategies, routines and anything with higher value to the company than its tangible value (Roos et al., 1997, p. 42). For decades, authors have recognized the crucial role knowledge plays as the most relevant source of competitive advantage (Nonaka and Takeuchi, 1995). In the era of BD, companies’ information ecosystems are increasingly expanding, with knowledge coming not only from small and specific groups of people but also from everyone, both inside and outside the organization, who is part of the knowledge development process (Fredriksson, 2015).

The first benefit scholars and practitioners highlight with reference to the adoption of BD technologies in organizations refers to the large volume of data that can be collected, stored and analysed to support decision-making (Wamba et al., 2015). Data volume, however, also holds threats to organizations, in the data collection and in the data consumption phase, largely due to the risk of companies erroneously assuming that data quantity necessarily improves its quality. The availability of huge amounts of data makes it difficult to discern between which is significant and which irrelevant (Kaisler et al., 2013). Additionally, firms need to assess the value of data adequately, i.e. to discern whether more data is better, or rather whether there is a saturation point at which already collected data is sufficient for increasing decision makers’ rationality. Companies have to define the extent to which it is possible to ensure that the collected data are accurate and reliable for decision-making (Wamba et al., 2015).

Scholars and practitioners are unanimous in stating that data quality critically contributes to the value creation process. Poor quality or inappropriate data have limited potential in assisting managers to take reasonable and successful decisions and, indeed, can be a waste of organizational resources (Schroeck et al., 2012). Although data quality has long been recognized as a critical element in determining its usefulness in decision-making (Redman, 1995), traditional protocols used to ensure data accuracy and validity have become impractical for validating BD. Data volume and data velocity can considerably impact time-to-information ratios (i.e. how much time it takes before data becomes useful information), so that new approaches to data qualification and validation are required (Kaisler et al., 2013) to conduct efficient and effective decision-making.
A major issue raised in BD design is related to the data consumption phase due to the fact that “it is easier to get the data in than out” (Jacobs, 2009, p. 8). In other words, while data entry and data storage are relatively easily handled with the tools and processes currently in use (e.g. those applied for relational databases), tools designed for accessing, processing and extracting very large quantities of semi-structured and unstructured data are still largely unknown or scarcely developed. Therefore, it can be argued that to date there is no perfect BD management solution, and that this constitutes an important research gap that needs to be filled (Kaisler et al., 2013).

Besides the issues related to data volume and data quality, scholars and practitioners have ascertained other relevant and ongoing challenges, related to data ownership and data security. On the one hand, there are significant uncertainties about data ownership (Kaisler et al, 2013) due to the availability of large volumes of data highly dispersed across a variety of internal and external sources, as well as to the emergence of professionals such as data brokers who control the distribution of data (Navetta, 2014). On the other hand, the availability of tons of potentially useful data makes it challenging for firms to “get the hands on that data” and to ensure that owners of useful data have adequate security measures in place (McGuire and Ladd, 2014).

Another big challenge brought on by the advent of BD is related to the need for revising the entire organization to maximize its value creation potential. When huge amounts of data become available, there is a significant risk that they will be locked into so-called “departmental silos”, i.e. in detached units such as R&D, manufacturing and service operations, thus impeding valuable and timely data exploitation (Brown et al., 2011). To overcome this risk, companies investing in BD technologies also have to transform their processes. Only such joint innovation will enable improved collecting and analysing data, that will bring more reliable insights on which decisions can be made regarding complex processes, particularly with processes which cross-organizational, departmental or business unit boundaries, or even cross-organizational borders (Mithas et al., 2013). Consequently, when firms intend to compare costs and benefits of an investment in BD, they should also consider revising and strengthening their governance processes, rethinking the allocation of decision-making power and re-engineering the role and configuration of the IT department. This is most likely to meet aims of maximizing the benefits of BD technologies and minimizing the payback period of the investment (Devaraj et al., 2007).

BD and related technologies enable the automation of complex decision-making, and set in motion fundamentally different ways of coming to decisions, turning from intuition-driven processes to data-driven processes (Fredriksson, 2015). An assumption that data-driven decision-making processes are required to gain a competitive advantage is likely to change traditional concepts of knowledge management (Tian, 2017). When data become the prime mover of business actions (Batra, 2014), decision-making is no longer a matter of hypothesis testing; rather, it increasingly depends on predictive models (Mayer-Schönberger and Cukier, 2013). This “datafication” could lead enterprises to the false assumption that data-driven organizations can substitute human interpretation with advanced predictive models and thereby automate their decision-making process. However, “as a large mass of raw information, BD is not self-explanatory” (Bollier, 2010, p. 13) and is subject to limitation and bias, “the more data and information are available, the greater the need for human judgement in decision-making” (Tian, 2017, p. 119). The availability of data does not automatically equal value creation (Zhang, 2013). In fact, interpretation remains central to data analysis (Boyd and Crawford, 2012).

Finally, the literature shows that adopting BD related technologies can significantly improve the learning processes within organizations (Higgins, 2014; Training Technology
Trends, 2015), thus enabling the transformation of individual knowledge (embedded in the HC) not controllable by the firm into a more structured knowledge, which is enclosed in organizational routines (i.e. SC). To reach this transformational aim, however, employees at all levels have to be aware of the opportunities offered by advanced analytics and how they function. This will ensure that the employees actually use and rely on these technological aids in their daily activities (Wamba et al., 2015). In this scenario, the success of a BD investment seems to depend on whether and to what extent managers are able to align the existing organizational culture and capabilities with the emerging tactics for fruitfully exploiting analytics (Barton and Court, 2012). This seems consistent with the ideas of rules, routines and organizational memory (Becker et al., 2005), according to which inertia or resistance to change depends on how strong the connections are between rules (the way in which things should be done) and routines (the way in which things are actually done).

Scholars have highlighted that the stronger the connection between the existing rules and routines, the more swiftly the new rules will be dismissed because of their inconsistency with the practices previously in force (van der Steen, 2009). If new approaches prompted by the investment in BD do not align with the firm’s actual decision-making processes, or if there is no clear plan for business to succeed, the investment will eventually fail because the employees will perceive the new tools as the prerogative of data scientists rather than of people involved in business management (Barton and Court, 2012). One possible way of overcoming this risk could be to actively involve employees with the team that implements the new BD infrastructure, during the whole implementation project.

Relational capital and Big Data
Strictly defined, relational capital (RC) is the knowledge an organization develops in conducting its business. Such knowledge is embedded in marketing channels and customer relationships (Bontis, 1998). More broadly defined, however, RC encompasses the knowledge embedded in all the relationships that organizations develop, with the different agents in its environment such as customers, suppliers, competitors and government, but also with brand names, trademarks and the corporate reputation (Cuganesan, 2005). As the most external dimension of IC, RC is difficult to develop and manage because it depends on the ability of an organization to create and maintain a stable and valuable network of inter-organizational relationships. These relationships increase the opportunity of creating, sharing and managing knowledge from outside to within the organization, thus generating a sustainable competitive advantage (Bueno et al., 2004).

BD is composed of both structured and unstructured data from internal as well as external sources. By using adequate analytics, it is possible to integrate different data sets and to integrate the entire information system of the firm, thus enhancing the usefulness of information for decision-making activities. Further, linking the company’s information system with external ones gives the company an extended and comprehensive view of its objects of interest. Practitioners have emphasized that companies have far more data than they are aware of and, more significantly, that much of this data is most likely stored outside rather than inside the companies’ traditional information systems (McGuire and Ladd, 2014). The advent of new technologies has enabled firms to seamlessly integrate the data sets of different entities along the supply chain to assure efficiency and gain competitive advantage. This integration can actually allow companies to capture and share accurate information timeously, so that they are able to coordinate their respective activities, improve supply chain performance (e.g. by shorter lead time and smaller size batches) and speed up decision-making by creating social knowledge (Devaraj et al., 2007).
When enterprises invest in new technologies with a view to integrating their different data sets to increase efficiency and effectiveness of information gathering and communication, they have to be aware of the related risks. For decades scholars have emphasized that knowledge is neither easy to access nor to coordinate because it is not well distributed, but rather, is embedded in the idiosyncratic and specific routines of single organizations (Zander and Kogut, 1995). Companies, therefore, have to develop intelligence gathering capabilities as well as processes to improve integration. This could be done via formal and informal communication channels that connect them to other interdependent organizations. In this way, they enhance relationships with distribution channel partners or cultivate supplier capabilities (Johnson, 1999).

Also, BD supports value creation processes in that such data provide relevant opportunities for organizations wanting to transform their operations, innovate their markets and better serve their customers (Ratten, 2015). BD technologies do have the potential to add value, also in terms of transparency, as the technology openly makes data available for business, thus enabling companies to collect and analyse large and complex kinds of information about their customers, and assisting them in defining market segmentation more narrowly. Further, BD supports experimental analyses that can test approaches and decisions, such as specific market programmes. It can also facilitate computer-aided product innovation, by means of embedded product sensors that can indicate customers’ responses (Kaisler et al., 2013, p. 996).

Finally, BD presents highly sensitive privacy issues that, as mentioned earlier, constitute one of the biggest challenges in both collecting and processing data. With specific reference to the need for creating stable, collaborative and valuable relationships with customers, suppliers, competitors and stakeholders in general, privacy issues can become a matter of making or breaking corporate reputation (Hirsch, 2013). The strategic role of corporate reputation in contributing to the achievement of a sustainable competitive advantage in the marketplace has received strong theoretical support (Grant, 1991). With the advent of BD, however, companies are now required more than ever to balance opportunities to exploit massive amounts of third parties’ data with the need to preserve their reputation. The way in which companies respond to the challenges of privacy issues will contribute to defining their reputation landscape in the next decades, “confering competitive reputational advantage on those organizations that can successfully address the concerns of consumers in this area and punishing those who cannot or will not” (Hirsch, 2013, p. 36).

Concluding remarks
The aim of the present study was to systematically identify and classify the main opportunities and threats associated with the exploitation of BD technologies within each of the three dimensions of IC by means of a SLR. Some interesting aspects about the state of the research on the investigated topic have emerged. First, the number of retrieved contributions and, even more significantly, their time distribution clearly suggest that we are dealing with an emerging field of research (Massaro et al., 2016). To the authors’ best knowledge, the present study is one of the first contributions to offer an integrated view of how the introduction of BD technologies can affect the IC dimensions. Second, our analysis of the source types highlights that research on the investigated phenomenon is strongly rooted in practice. In fact, practitioners are increasingly paying attention to the potential of BD in creating value and, not surprisingly, nearly 40 per cent of the selected contributions come from the professional realm.

The developed framework offers some valuable insights on the opportunities and risks that an investment in BD can bring to organizations from an IC perspective. First, BD
technologies are likely to contribute significantly to the development of HC items, by enhancing the learning cycles within the organization and stimulating the decision-making processes of the employees at all levels (Shah et al., 2012). An investment in BD can also support the transformation of individual knowledge embedded in HC into a more structured kind of knowledge, enclosed in corporate organizational routines, i.e. as SC (Higgins, 2014). Nevertheless, in approaching this transformational aim companies need to comprehensively revise their knowledge management processes to allow employees and managers to exploit the informative potential of an inter-organizational data set fully and timeously (Brown et al., 2011). Further, employees need to rely on a BD-based model to apply the new technologies in their daily activities and so boost the process of knowledge structuring. This requires adequate educational and training programmes as well as all these employees being actively involved during the whole BD installation project (Wamba et al., 2015).

Second, BD offers the opportunity to integrate different data sets from multiple entities along the supply chain (Devaraj et al., 2007). In doing so, firms can enhance their relationships with distribution channel partners or cultivate supplier capabilities, thus improving their RC items (McGuire and Ladd, 2014). In this process, firms have to be aware of the risks related to introducing BD technologies. Such risks mainly arise from the fact that external knowledge is not easy to access, as it is embedded in the idiosyncratic and specific routines of single organizations.

It can, therefore, be argued that with support from adequate managerial solutions for overcoming the relevant challenges, an investment in BD can enhance the value creation process of the firm. BD, indeed, can provide the organization with the opportunity to develop and strengthen its distinctive, firm-specific competences, which are hardly replicable by competitors and constitute a relevant source of competitive advantage (Grant, 1991). Further, BD supports the creation of utility value, conceived as the perceived usefulness of a company’s products and services (Dumay, 2016). This comes from the provision of valuable opportunities for organizations to enhance market segmentation and product innovation according to customers’ direct perceptions (Mithas et al., 2013). Finally, BD also has the potential to add value in terms of transparency and better corporate reporting (Vereckey, 2013), thus contributing to social value creation.

To sum up, it emerges that the BD era has not so much changed the risks and opportunities highlighted in previous literature, but it has significantly amplified the relevance of some of these risks. For example, BD highlights the risk of overestimating data quantity to the detriment of data quality, or the risk of poorly managing privacy issues, that are increasingly associated with corporate reputation (Hirsch, 2013). All in all, the literature analysis suggests that firms do not experience radical change in terms of risks and opportunities when they invest in BD; rather, the advent of such technology has significantly amplified the magnitude and the speed with which these threats manifest themselves. Thus, a revision is required of the traditional managerial solutions, or at least of the way in which such solutions are applied to overcome the identified risks. One could, therefore, argue that “old problems” require new solutions and that the main changes brought on by the advent of BD do not affect “what” has to be faced but “how” organizations have to face it.

Implications, limitations and future research
The present study has both theoretical and practical implications. From a theoretical perspective, this study contributes to the fourth stage of IC research, as it offers some preliminary insights in understanding how the adoption of BD technologies can affect the development of intangible assets from a value creation perspective. Moreover, the conducted
research can offer first considerations on how BD and the related technologies can affect the process of value creation from different perspectives, e.g. those of social and utility value. Further, it contributes to the information system literature, providing valuable insight as to how the BD attributes can be related to the management of the IC dimensions.

From a practical standpoint, the proposed interpretive framework represents a useful decision-making tool for organizations that are investing or intend to invest in BD and analytics, to identify the main threats and opportunities posed by such an investment. Firms can use the interpretive framework to map and evaluate the likelihood of the identified threats and opportunities being realized, as well as the possible magnitude of such threats and opportunities. Such assessment can assist in planning and applying adequate solutions with the aim of maximizing the project’s benefits and reducing the risk of a failure. Further research is needed, however, to confirm or revise the findings derived from the theoretical analysis. The proposed framework could be validated by means of conducting case study analyses, which could also develop understanding of how the proposed scheme can be implemented in different organizations.

One limitation of this study relates to the adopted methodology. In fact, time constraints, language constraints and imperfect information made it difficult to cover all the literature that directly or indirectly deals with the interaction between IC and BD. Also, the selected contributions were coded and analysed manually instead of by means of computer-aided coding. Even though manual coding could be considered more subject to bias, it represents an adequate solution when the extracted literature is relatively scarce and comes from different sources. Moreover, manual procedures allow us to understand and code “words with similar meaning” according to their true sense (Guthrie et al., 2012, p. 71). Finally, all literature reviews, including SLRs, arguably, are biased due to the intervention of the researchers simply due to their choosing the body of literature to be reviewed. Nevertheless, the adopted research methodology in this case has allowed us to collect enough publications and seminal works on BD and IC to offer a synthetic picture of the phenomenon under investigation.

References


About the authors

Federica De Santis is a Junior Lecturer at the University of Pisa (Italy). Her research interests are intellectual capital, management accounting, management information systems and auditing. She teaches Financial Accounting, Management Information Systems and Auditing and Management Control at the University of Pisa. Federica De Santis is the corresponding author and can be contacted at: federica.desantis@unipi.it

Claudia Presti is a PhD Student at the University of Pisa. Her main research interests are management information systems, risk management and management accounting.