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Intellectual Capital in the age of Big Data: Setting up the research directions

Giustina Secundo
Researcher and Assistant Professor of Project management
Department of Engineering for Innovation - University of Salento
Ed. IBIL – Campus Ecotekne
Via per Monteroni sn – 73100 Lecce (Italy)
E-mail: giusy.secundo@unisalento.it

Pasquale Del Vecchio*
Researcher and Lecturer in Business Management
Department of Engineering for Innovation - University of Salento
Ed. IBIL – Campus Ecotekne
Via per Monteroni sn – 73100 Lecce (Italy)
E-mail: pasquale.delvecchio@unisalento.it
* Corresponding author

John Dumay
Associate Professor of Accounting
Department of Accounting & Corporate Governance
Macquarie University
E4A Eastern Road
NSW 2109 Australia
E-mail: john.dumay@mq.edu.au

Giuseppina Passiante
Professor of Innovation Management
Department of Engineering for Innovation - University of Salento
Ed. IBIL – Campus Ecotekne
Via per Monteroni sn – 73100 Lecce (Italy)
E-mail: giuseppina.passiante@unisalento.it

Abstract

Purpose: The study aims to provide a contribution at the literature on Intellectual Capital (IC) in the light of the emerging paradigm of Big Data. Based on a literature review, the paper is conceived as a momentum for exploring the emerging trends and implications of the Big Data movement for the agenda of researchers and scholars in the field of IC.

Design/methodology/approach: A literature review discussing contributions from IC research and Big Data highlighting novel and emerging issues, based on the following dimensions: IC for Organizational Value, the evolution of IC stage of research and Big data: from the technological to the managerial paradigm. Moving from these areas, the novel and emerging issues of contribution will be highlighted to set – up the research directions.

Findings: A conceptual multi-level framework demonstrating how Big Data perspective validates the need to shift IC research from the organization to the eco-systems focus is presented. The framework is organized into four main dimensions: Why: the managerial reasons for using Big Data for IC; What: the typologies of Big Data enhancing the IC practices; Who: the organisation's stakeholders involved and impacted by IC value creation process supported by Big Data; How: the Big Data processes suitable for IC management.

Originality/value: The novelty of the paper resides in the investigation of the effects and implications that Big Data can offer to IC management, by supporting the emergence of a fourth stage of IC research. Additionally, it provides an original interpretation of IC research through Big Data lens.

Research implications: The paper provides avenue for future research in this emerging field of investigation. Key research questions are settled up to move ahead the contribution that the Big data approaches could provide the stage of IC research.

Practical implications: The paper provides implications for practices, in terms of: outlines the socio-economic value of Big Data, from and about the organizational ecosystems; identifies opportunities for existing companies for renewing their value proposition through Big Data; and outlines new tools for managing Big Data to support disclosing IC value drivers and for creating new intangible assets.

Keywords: Intellectual Capital, Big Data, IC Fourth Stage, Stakeholders, Value Creation, Ecosystem.

Paper type: Conceptual paper

1 Introduction

Over recent decades there has been a rapid global transition from an industrial to a knowledge base economy in which wealth is created by developing and managing knowledge and intangible assets (Andriessen, 2004; Ricceri and Guthrie, 2009; Dumay and Garanina, 2013) commonly intended as intellectual capital (IC). The fields of IC have always distinguished between data, information and knowledge; one of the basic concept is that IC deals with valuable organizational assets which deserve great attention of managers (Erickson and Rothberg, 2015). IC is valuable enough to be identified, managed, and protected and perhaps granting competitive advantage (Erickson and Rothberg, 2015).

In this scenario, the emergence of Big Data can offer new interpretative lens to IC management. Big Data is as one of the most representative paradigm of the complexity and turbulence of the knowledge economy. By Big Data the authors mean that huge amount of data potentially useful to generate valuable knowledge and tangible benefits for organizations in their process of value creation. Other definitions include the large, complex and growing volume of data generated continuously by a multiple, autonomous and smart sources (Wu et al., 2014; Kaisler, et al., 2013). High-volume, high-velocity, and/or high-variety of information assets are identified by Gartner (2012) as the main features of the Big Data paradigm for which new processes supporting decision making, insight discovery and process optimization are required. The volume, velocity and nature of Data encompassing the concept of Big Data requires the adoption of more performant tools and systems of data management.

As the volume, velocity, and variety of data (Laney, 2001) increase, it becomes more compelling than in the past to take advantage of the data. Moreover, scholars and researchers in the information management field identify Veracity, Variability and Value as additional Big Data dimensions (Gandomi and Haider, 2015) by highlighting the need to comprehend the challenges associated with translating them organizational value. The

firms' Intellectual Capital (IC) can be interpreted as the most valuable forms of Big data when data are transformed into organizational value.

For the purpose of this paper, the authors define IC as "… the sum of everything everybody in a company knows that gives it a competitive edge … Intellectual Capital is intellectual material, knowledge, experience, intellectual property, information… that can be put to use to create value" (Dumay, 2016). The inclusion of the word 'value' in the definition is because although value includes monetary wealth, the outputs for the organisation's stakeholders should be expressed not only in terms of monetary assets. Expanding the concept of value creation beyond organizational wealth creation into wider society aligns with Dumay and Garanina's (2013, p. 21) concept of fourth stage IC research which helps "navigate the knowledge created by countries, cities and communities and advocates how knowledge can be widely developed thus switching from a managerial to an ecosystem focus". However, organizations only identify a small part of this value and limited tools exist to create, manage, and measure it. Among the emerging approaches, the IC management based on qualitative measurement models for IC in decision-making (Kujansivu, 2009; Lönnqvist et al., 2009) and the use of narrative to explain the numbers (Dumay and Rooney, 2016) are emerging.

The emergence of Big Data is blurring the boundaries between the internal and external knowledge assets that companies leverage to gain and sustain their competitive advantage (Lerro et al., 2011; Schiuma, 2009). Creating a bridge between knowledge inside the organisation (human capital) and knowledge outside the organisation (relational capital) is strategic (Borin and Donato, 2015). Big Data shifts the IC focus from the organization to the eco-systems to create knowledge on a wider scale (Dumay, 2013). This shift aligns with fourth stage IC research (Dumay and Garanina, 2013) that has now reached its cusp (Dumay, 2016).

Thus, this paper aims to contribute to the literature on the nexus of IC and Big Data (McAfee and Brynjolfsson, 2012) by exploring emerging researchers trends. Furthermore, this is expected to overcome the fragmentation of the debate related to Big Data, mainly for what concerns its managerial implications and perspectives. The authors are more concerned with how Big data helps organizations to create value for the society and the

ecosystem in which they operate (Dumay and Garanina, 2013; Dumay, 2014) in terms of sustaining the process of Intangible assets creation and management. The perspective of Big Data validate the need of shifting from an IC focus on the organization to the eco-systems perspective, more responding to a multidirectional process of knowledge and intangible assets creation and management.

The paper is structured as follows. Section 2 introduces the background related to IC research. Section 3 presents a literature review of recent Big Data trends. Section 4 presents a conceptual framework to demonstrate how adopting an IC approach is trivial for valorizing that huge amount of data available for companies and organisations more in general. Finally, conclusions end the paper with avenue for future research.

2 The background of IC and Big Data research

2.1 IC for organisational value

IC is a multifaceted and elusive topic. Both static and dynamic perspectives are employed to analyse it (Kianto, 2007; Kianto et al., 2014) and there is no precise agreement on its definition even if a general consensus is on the fact that IC is essential for value creation in companies (Moustaghfir and Schiuma, 2013). The inclusion of the word 'value' in the definition (see introduction) is because although value includes monetary wealth, the outputs for the organisation's stakeholders should be expressed not only in terms of monetary assets. Accordingly, Dumay (2016) also advocates that organizations produce utility, social and sustainability value. First, utility value is the usefulness of the goods and services organisations produce and is "the price which a person is willing to pay for the fulfilment or satisfaction of his desire" (Marshall, 1920, p. 78). Second, social value, often described as social capital, relates to the benefits an organisation provides to society in general (Nahapiet and Ghosal, 1998). Many organisations are so large that they affect the everyday lives of the society in which they operate (Dumay, 2016). Third, organizations can also provide sustainable value and is the cornerstone of what Dumay (2013) refers to as being crucial to the fourth-stage of IC research. However, it is debatable if any organisation is truly sustainable (Gray, 2006), especially if we take the Bruntland (1987) definition of sustainability to heart, that is to "meet the needs of the present without compromising the ability of future generations to meet their own needs".

Dumay and Garanina (2013) note many methods are used to define it as a whole, or identify the different elements that create it. There is a broad consensus in literature about the positive effect of IC on competitive advantage and profitability (e.g. Edvinsson and Malone, 1997; Reed et al., 2006; Chiucchi, 2013). The value of intangible assets and IC to the organization has long been recognized, going back to classic economists such as Schumpeter (1934) and management theorists such as Drucker (1991). The idea that such intangibles might be a key source of competitive advantage is explained in the resource-based theory of the firm (Wernerfelt, 1984), that recognized the key role of knowledge in obtaining and sustaining competitive advantage. Indeed, IC have to do with identifying, measuring, reporting, disclosing and managing knowledge assets effectively in order to gain this competitive advantage. IC grew out of accounting and centers on identifying and measuring the knowledge assets of the organization (Bontis, 1999; Edvinsson & Malone, 1997; Stewart, 1997). There is a certain general agreement in classifying IC in three categories: human capital, relational capital, structural capital (e.g. Bontis, 1999; Sveiby, 1997; Lev, 2001; Andriessen, 2004; Guthrie et al., 2012). Human capital generally has to do with job-related know-how and learned expertise, structural capital with enduring knowledge existing within the organization (e.g. corporate culture, systems and procedures), and relational capital with knowledge concerning external relationships (e.g. customers, suppliers, regulators).Looking at the three dimensions separately is insufficient to understand IC. Human capital, Relational capital and Structural capital can be useful for organisations in general only if they are connected through connectivity (Vagnoni and Oppi, 2015). The connectivity among the three dimensions is introduced as the fourth dimension to consider, to highlight that in especially knowledge intensive organisations, the three IC dimensions are related each other (Habersam and Piber, 2003). The presence or the simple mix of IC elements does not promote competitive advantages without effective management (Teece, 2000; Mouritsen, 2006). This implies a view of IC not as a stock of resources, but rather - if effectively managed - as a bundle able to create value for organisations (Andriessen, 2005).

Over the last two decades, researchers and practitioners have developed a plethora of IC measurement models (Dumay and Roslender, 2013). Dumay (2009) criticizes the quest to develop more IC measurement frameworks, because a sufficient number exist and there is

confusion as to what is the right framework to use. Therefore, developing just another measurement framework would add little if anything to understanding IC in a traditional organisational setting. Thus, researcher need to reinvent approaches to facilitate a more balanced approach to managing, measuring, and reporting IC to contribute to organisational strategic management (Secundo et al., 2015). Dumay and Garanina (2013) argue the focus should be on developing IC theory in practice and effective IC management through praxis in order to provide a better view of the process of developing IC and the actual impact of IC in action.

2.2 The evolution of IC stage of research

The evolution of IC research can be traced as organized into four main stages. Originally, Petty and Guthrie (2000) outlined two stages associated with developing IC as a research field. The first stage of IC research focused on raising awareness and understanding IC's potential for creating and managing a sustainable competitive advantage in private organizations. This stage is grounded in the work of practitioners in the 1980s and 1990s. The main focus was the awareness of IC as something significant to be measured and reported, but with little empirical research provided in support (Petty and Guthrie, 2000).

In contrast, during the second stage, IC was established as an approach related to strategic management and evidence was gathered to justify its use (Petty and Guthrie, 2000, pp. 155-6). In this stage, a plethora of IC frameworks were applied in practice to demonstrate their potential value creation impacts. Different classifications were created, which helped to define and group different methods of IC evaluation (Boedker et al., 2008; Ricceri, 2008). As a result, by the mid-2000s, more than 50 methods were created (Sveiby, 2010, Dumay and Roslender. 2013). Dumay argues that the focus on measuring and reporting IC has led many scholars into an "evaluatory trap" resulting in them implementing and improving models and frameworks already in use and therefore preventing them from fully exploring and understanding the potential of IC in practice (Dumay, 2014). He highlights the need to move forward, towards a third stage of IC research (Dumay, 2014) to study how organizations understand, adapt and apply IC as a management technology (Guthrie et al., 2012), especially in cases of attempting to manage IC for the first time. Advanced models developed in the third stage (Guthrie et al., 2012) adopted the evolved notion of IC as a dynamic system on intangibles resources based on knowledge. In these kinds of models, attention focuses on the interactions between the IC components and intangible activities essential in the production, maintenance and development of

intangible resources (Silvestri and Veltri, 2011). The assumption behind these models is that measurement of IC is necessary for the management of knowledge, and their main aim is to identify the paths of an organization's value creation based on knowledge (Dumay and Garanina, 2013).

Some features are considered relevant when analyzing and defining an integrated IC management model: the potential value of IC, its dynamic and the organization-specific nature. Dumay and Rooney (2011, p. 344) found "that it is possible to effectively implement IC practices without necessarily needing concrete IC measures because organizational measurement needs continually evolve depending on factors such as the characteristics of individual organizations; changing internal and external political, social and economic environments; and evolving business plans and strategies". Another essential aspect of the third stage is empirically researching IC practices inside organizations rather than IC measures (Guthrie et al., 2012). Other researchers have highlighted the need for reporting and disclosing IC both to internal and external stakeholders, underlining the link with stakeholder theory and legitimacy theory (Guthrie et al., 2006).

These assumptions form the basis of a further stream of research often identified as the fourth stage. The main pillar is the possible ways to create a bridge between knowledge inside the organization, known as human capital, and knowledge outside the organisation, known as relational capital (Borin and Donato, 2015). This evolution of focus from previous concepts of IC converges the dimensions of human, relational and structural capital, towards new dimensions of IC, where the social dimension of IC is also taken into account, incorporating citizenship and global brain power. This recalls the third and the fourth stage of IC research (Guthrie et al., 2012; Dumay and Garanina, 2013), with more performative approach, aimed at analyzing how IC works in organizations, how it manifests itself, and how people, processes and relationships are mobilized in relation to it (Cuganesan, 2005; Mouritsen, 2006; Cuganesan et al., 2007; Dumay, 2009).

Dumay and Garanina (2013) underline a broader view on the path of IC, focusing on the IC of countries, cities and communities as opposed to specific firms. This approach shifts the focus of IC to the ecosystems at national, regional or local level, where knowledge could be created and developed on a wider scale.

2.3 Big Data: from the technological to the managerial paradigm

Big data is a topic of growing relevance into the agenda of scientists and practitioners (Gandomi and Haider, 2015). Assumed the ubiquity of the term (Ward & Baker, 2013) Big Data refers to any set of data that, with traditional systems, would require large capabilities in terms of space of storage and time to be analyzed (Kailser, et al., 2013; Ward & Baker, 2013). As an emerging paradigm in managerial and practice debate on ICT (Information and Communication Technology) and business management, the main characteristics of Big Data paradigm have been identified into the large size of dataset, the presence of structured and unstructured data, the short life-cycle of contents (Laney, 2001; Kaisler, et al., 2013).

This has caused the identification of a preliminary set of critical dimensions of Big Data paradigm such as Volume, Velocity, and Variety of Data (Laney, 2001; McAfee and Brynjolfsson, 2012). About the Volume, as primary dimension related to the storage capacity of servers and databases, the space currently required is assumed in the scale of exabytes, (10^{18}) and beyond (Kaisler et al., 2013). In an organization context, Volume can so be defined as the total amount of data available (Kailser, et al., 2013). As for the Velocity, identified as measure of the speed of data creation, sharing and storage (Kailser, et al., 2013), in some contexts (i.e., transports and mobility, ecommerce, healthcare, etc), the speed of data creation is more meaningful and strategic of the volume (McAfee and Brynjolfsson, 2012). Variety is, instead, the measure of diversification and fragmentation of data, that can have the form of text, images, videos, audio, etc (McAfee and Brynjolfsson, 2012; Kailser, et al., 2013). The richness of nature resulting from the several Big Data sources highlights the rate of obsolescence emerging in the field while in an analytical perspective can be assumed as the main challenge to afford.

The dramatic decrease in the cost of data storage and data processing is driving the diffusion of Big Data. More power and decreased costs have led to an ability in many firms to store ever greater amounts of data and conduct more in-depth analysis on a regular basis, either through their own IT systems or in the cloud (Vance, 2011). Cloud services are available at reasonable costs by any number of big providers, including such well-known names as amazon.com, Google, and Microsoft. More recently the rising of cloud open-source software framework for distributed storage and distributed processing of those large datasets, such as Hadoop, has enlarged the set of services available for companies in terms of data storage, repository and analysis (Hashem et al., 2015).

Furthermore this aspect consolidates the perspective that in the Big Data world the novelty is mainly into take advantage from data becomes more compelling.This has solicited the recent contributions of scholars and researchers in identifying additional dimensions of the Big Data paradigm more focused on the nature and exploitation of data, such as Veracity, Variability and Value (Gandomi and Haider, 2015). This second set of Vs result to be more coherent with managerial implications and speculations emerging from the temptation of managing Big Data in an IC perspective. This is the case of Veracity that implies the need of assuring trustful and certain interpretation of data for effective outcomes. As for the Variability, this dimension arises in at least twofold perspectives: a first one related to changes occurring in the data (the continuous updating of status and the usage of different means) as well as in the interpretation of data available (Fan & Bifet, 2013). As for the Value, this is recognized as the most valuable and comprehensive challenges associated to. Value in Big Data is referred to the usefulness in decision making (Kaisler, et al., 2013), improvement of business performances (McAfee and Brynjolfsson, 2012), source of innovation in product (Mayer-Schönberger & Cukier, 2013) as well as in business model (Brown et al., 2011) a more powered predictive activity (Kailser, et al., 2013) and source of customization (Brown et al., 2011). According to McKinsey, Big Data are now diffusing into all the areas of a company becoming a strategic factor for companies' competitiveness. Jin et al., (2013) also argued as Big Data are radically changing the world, affecting daily life of individuals, companies and public institutions. Scholars and researchers are recently focused on the nature of data (i.e. structured or unstructured, video, images, text, codes,), methods and tools, and analytics. About the nature of data, it is possible to distinguish two main type of Big Data: data from and about physical world (all that is obtained from sensors, scientific observations etc) and data from and about the human society (all that is obtained from social networks, internet, marketing, etc) (Jin et al., 2015).

Converting unstructured data into structured numbers is now mandatory to transform the huge amount of data created over the world into organizational value. This means to developing systems for analyzing text, voice, and video data, by converting them into numbers for analysis. This implies the adoption of basic statistical processing with either proprietary (SAS, SPSS) or open source (R) statistical programs. However, instead of the traditional hypothesis-based approach to statistical analysis (in which the analyst or

decision-maker comes up with a hypothesis, and then tests it for fit with the data), Big Data analysis is more likely to involve an approach called "machine learning" (Del Vecchio, et al. 2014). Machine learning results to be extremely useful to quickly generate models to explain and predict relationships in so fast-moving data. But it requires times and a sufficiently large dataset for training of system in order to assure high responsiveness and analytical performances.

Accordingly, Big Data offers several opportunities and challenges. Big Data is considered valuable for organisations, creating new opportunities for IC management. Simultaneously, a number of challenges should be addressed to create value from Big data for IC. However, while it is largely recognized the relevance of the paradigm, how to transform all those data in tangible or intangible assets and IC is still missed (O'Neil and Schutt, 2013; Jin et al., 2015).
Framed in the above premises, for the goals of this study we will refer to Big Data approach as the conceptual synthesis of the different types of data, the strategies and tools discussed above.

3 Intellectual Capital and Big data: a conceptual framework

As highlighted in the literature review, the fourth stage of IC research emerged recently (Borin and Donato, 2015). This evolution of focus from the IC organisation' perspective towards an IC eco-system focus (see also Gray, 2006; Edvinsson and Lin, 2008) is emerging, due to the blurring of borders between the organization and the ecosystem. At the same time, structured and unstructured data can derive from different sources located inside the organization or within the wide ecosystem, by contributing to the creation of Big Data. Big Data can be generated inside and outside the organization, from all the company's stakeholders (customers, employees, suppliers, users, etc ..), they can also be produced from internal sources (e.g., sensor data) and external sources (e.g., social media). Their relevance is due, in particular, to the potential value added, to the contribution of transparency with immediate performance feedbacks, experimentation with quick results, more objective decision-making, innovation in products and business models (Manyika, et. al., 2011).

With the aim to provide a systematization at the main areas of investigation emerging from the intersection of both the fields of research and to contribute at the setting up of a future research agenda, this section describes the pillars of the conceptual framework emerging from the adopting Big Data approach for managing IC. Moving from the conceptual background discussed in the previous sections, a conceptual framework (see Fig.1) is defined as composed by four main categories of concepts referred to both the two field of research as resulting the *Why* component, highlighting the reasons behind and the outcomes resulting from the contribution of Big Data for IC management; the *What* component, containing the typologies of Big data contributing to the development of the intangible assets of the organizations; the *Who* component, identifying the organization's and the ecosystem's stakeholders being impacted or contributing to IC and Big Data; finally, the *How* component, illustrating the main processes supporting the adoption of a Big Data approach in the IC management.

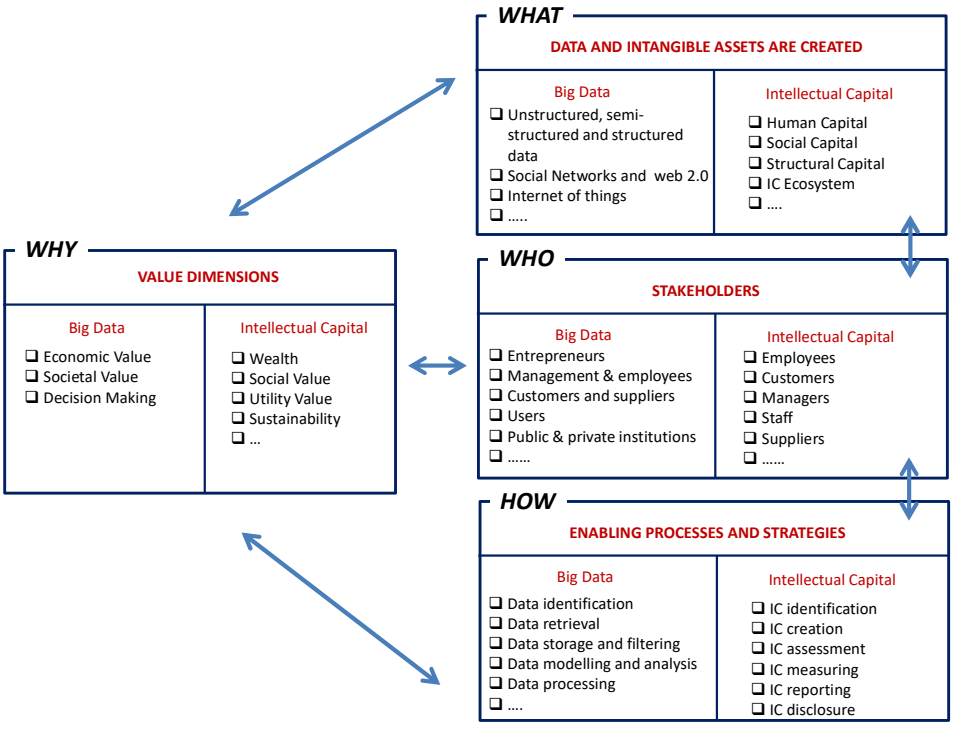

Figure 1. Conceptual framework: Big Data for IC Management

The next sections will detail the mentioned components of the framework (Figure 1).

3.1 Why: the Value generated by Big Data for IC

A first dimension has been identified into the *Why,* as the main motivations and objectives addressing the opportunity of adopting Big Data into the strategies and practices of IC management. The main motivation resides in the dimensions of value emerging in the literature as the most recent and challengeable perspective of Big Data phenomenon. As it is known from knowledge management and IC approaches, the information and data do not reveal their full value until insights are drawn from them. This allows to conclude that it is not the volume of data neither the velocity by which organizations can create, storage and manage them to create competitive advantage for organizations, but the way by which them will be able to process those data to derive specific inputs. The meaning of value in Big Data can assume a threefold perspectives, such as economic, social and decision making (Fredriksson, 2015). About the economic perspective, Big Data are assuming a relevant economic weight in the competitive positioning of organizations, public and private, as well as of nations, in reason of the potential benefits that can be derived in terms of productivity, users involvement and customers satisfaction (Manyika et al., 2011). The adoption of a Big Data approach is expected to optimize the costs, increase revenues, and make more efficient organizational processes (Manyika et al., 2011). Additionally, Big data can impact positively on the organizational transparency, the continuous innovation process in terms of products, processes and business models, a more deepen and scientific segmentation of customers, the availability of automated algorithms supporting the decision making, (Fosso Wamba et al., 2015; Fredriksson, 2015; Manyika et al., 2011).

As for the social dimension of value, Big data can create the basis for a more equal and inclusive society, by allowing to address the challenges related to of Societal Value through the potential to solve many challenges nations have in science, education, environment and medicine towards more diffused wellness. (Fredriksson, 2015; Ohlhorst, 2012). Big Data in the societal perspective is seen as powerful instrument for creating advanced solutions in the different fields of human, political, economic and social areas of application. (Boyd & Crawford, 2012). About the decision making dimension of value, it has been noted as this perspective presents an overlapping between the previous two. In all cases, it is evident as Big Data can opportunely support the decision making process both in the economic and social fields by enhancing the decision-making () approach of organizations with the support of automated and advanced algorithms of analysis.

(Fredriksson, 2015; Desouza & Jacob, 2014; Power, 2014). By allowing to to collect and analyze large amount of information, Big Data provide useful material and statistics to assume decisions. Decision-making is enhanced only when analytical techniques are applied and some elements of human interaction is applied (Zhao, 2013).

The value generated by Big Data results coherent with the strategic objective addressing an IC approach, as identifiable into the organizational wealth, social value, utility and sustainability (Dumay, 2016) to move beyond the monetary value generated by IC and intangible assets more in general. With the blending of data and information vs. knowledge and intelligence, we see an opportunity for cross-fertilization between Big Data/business analytics and the fields of IC, and related disciplines. This because, moving from the definition of Big Data, the valuable dimension of this large amount of info available for organizations is associated to their management and transformation in one or more categories of intangible assets (IC). Gaining insights from data through statistics, mathematics, econometrics, optimization and simulation approaches, largely recognized as Big Data Analytics, is the main goal of organizations in shaping the large amount of data available. This invaluable information is leveraged in decisions related to product promotions, placement, and staffing so contributing to leverage the intangible assets of the organization.

Therefore, using Big Data with an IC lens opens the opportunity to develop tools for organizational renewal and consolidation of competitive positioning. This large meaning of value in the discussion on Big Data becomes useful when it enhances decision-making and organizational value creation.

3.2 What: the Big Data and Intangible Assets created

About the *what* component of Big Data relevant for an IC approach, it is reasonable to assume that all the data and info available in the emerging paradigm of Big Data can support the implementation of IC in all its components. Specifically, the main categories of data, classified into the unstructured, semi-structured and structured can represent suitable basis for the IC practical development. On the basis of their nature, those data categories can be referred to data generated by social networks and web 2.0 technologies as well as by smart devices, sensors and tags as main sources of the so called Internet of Things. Structured data can be of two types: machine-generated and human generated ones. The first are data created by multiple sources such as sensor data, web log data from web activities and point-of-sale data from product purchasing. (Hurwitz et al.,2013)

The human generated, are data including information about users filled- in online and or generated every time users click a link on a website. Unstructured data sre those data do not follow a specific format, such as documents, videos and e-mails,. Also in this case, it is possible to distinguish between machine-generated unstructured data (i.e. satellite images,pictures, videos, etc) and human-generated un-structured data (i.e.social media data, mobile data and web-site content.) A third category of intermediated data has been identified into the semi–structured data, (Ohlhorst, 2012).

By referring to the IC dimensions, those typologies of data support the development of the main categories of intangible assets, such as human, social and structural capital. Moreover, the changed IC definition including the interrelations among the components requires a focus on the organization's ecosystems where intangible assets and IC are created and developed on a wider scale (Borin and Donato, 2015).

Specifically, by focusing on the different Big Data sources, organizations can create, storage and manage data from and about their employees, managers and collaborators (i.e human capital), from and about suppliers, customers and coopetitors (i.e. social capital), as well as they can create and manage data for and from physical and virtual infrastructures, machines and tools (i.e. structural capital). The enlarged representation of the organizational ecosystem, resulting from the ongoing debate on IC stages, provides a concretization of the different categories of big data generated by all the actors involved in, as well as, a preliminary comprehension of the flows of information, data and knowledge created by the interactions taking place in the organization's ecosystem.

3.*3 Who: the stakeholders involved in IC and Big Data*

As for the *Who,* this dimension refers to the large categories of stakeholders impacting on the creation, sharing, and processing of Big Data as well as on the community of stakeholders that in a value network perspective can support the effective implementation of an IC practices. The term stakeholder is used in a broad sense (Freeman, 2010), as to include all the actors that somewhat affect or are affected by a specific process or project or organization. Organizations are open systems: they affect and are affected by their ecosystem. The main categories of organisation's stakeholders in a Big Data perspective can be identified into the entrepreneurs, managers and employees, customers and suppliers, users, public and private institutions. The IC perspective presents almost the same categories of actors, by highlighting the convergence of both the two approaches

toward a wide large community of stakeholders. Organisational value precisely emerges through joint collaborative endeavors, where these different stakeholders bring together their assets, competences and specificities. This requirement calls for the necessity to introduce the concept of "Collective Intelligence" that appears where local and distributed assets and expertise are coordinated to achieve a collective (although not necessarily consensual) goal (Mulgan et. Al., 2012).

It's clear that an organization can be interpreted as a "collective intelligence systems" (Secundo et al., 2016) in which different Big Data source, including also data from customers, partners, employees, competitors and supply chain, are coordinate toward the creation of new IC for organizational value creation.

3.4 How: the enabling process to create value from Big data and IC

Finally, the *how* component resumes the procedures, approaches and managerial practices useful to create value from data and intangible assets for the society in which the organization operates (Dumay and Garanina, 2013; Dumay, 2014). Next, it is important to move from the profile of the knowledge economy as socio-economic context in which the competitiveness of companies and individuals is more and more dependent on the capabilities of developing, capturing and exploiting IC. Expanding the concept of value creation beyond organizational wealth creation into wider society aligns with Dumay and Garanina's (2013)concept of fourth stage IC research. This helps "navigate the knowledge created by countries, cities and communities and advocates how knowledge can be widely developed thus switching from a managerial to an ecosystem focus" (Dumay and Garanina, 2013, p. 21).

In a Big Data perspective, the main features are represented by the data identification and retrieval, data storage and filtering, data modeling, analysis and processing. In the same time, a focus in IC allows to derive the following items related to the IC identification, creation, assessment, measuring, reporting and disclosure. Moving from the evident overlapping of processes and actions, the analysis allows to comprehend how also in this perspective, a Big Data approach can contribute to the design and execution of a IC strategy.

Big data and business analytics bring new capabilities for the organisational value creation, and we need to discuss how they fit within the IC universe. The potential value of Big Data is unlocked only when leveraged to drive decision making (Gandomi and

Haider, 2015). To support such evidence-based decision making, organizations need efficient processes to turn high volumes of fast-moving and diverse data coming from the organization ecosystem into meaningful insights and organizational value.

The overall process of extracting insights from Big Data can be broken down into five stages (Labrinidis and Jagadish, 2012). These five stages form the two main sub-processes: data management (composed by the processes of acquisition and recording, extraction, cleaning and annotation, interaction, aggregation and representation) and analytics (composed by modelling and analysis, interpretation). Data management involves processes and supporting technologies to acquire and store data and to prepare and retrieve it for analysis. Analytics, on the other hand, refers to techniques used to analyze and acquire intelligence from big data (Gandomi and Haider, 2015). About the Big Data analytics and the way by which their management can support the process of value creation required in a IC perspective, three main categories of analytical process can be identified: predictive, descriptive and prescriptive (Wang et al., 2016). Based on growing level of usage of mathematical algorithms, the different types of Big Data analytics offer sophisticated solutions for the comprehension of organizational wealth, prediction of future scenarios of development and assumption of decisions. In addition, more evoluted techniques of analysis such as clustering, sentiment analysis and machine learning can opportunely support the exploitation of Big Data in the conception and execution of IC strategy.

4 Discussions

The four dimensions of the framework previously described have allowed to synthetize the main evidences arising on the intersection of Big Data and IC research streams. Specifically, the diversified and multi-source nature of data emerging from the organizational ecosystems, more and more populated by a community of knowledgeable actors, opportunely processed through approached of growing complexity, is expected to sustain the achievement of value creation by organizations, public and private.

Big Data, in its larger definition, resulting from the merging of structured and unstructured data, created from and about actors populating the organizational ecosystem, could represent with its challengeable dimensions of volume, velocity and variety, the backbone of a revised model of representation of IC (see Figure 2). Specifically, IC in a Big Data perspective means to develop approaches, strategies, technologies and

infrastructures to acquire, storage, and manage all that data continuously created in, out and around the organization, to include all the ecosystem dimension. This moves toward an innovative management of all the components of IC, as composed by human, social and structural capital and more recently its ecosystem dimension. This is in the literature background associated to the shift toward the fourth stage of IC. Based on techniques and processing capabilities of growing complexity, the management of Big Data in a IC perspective is expected to allow the identification of punctual goals and key performance indicators, the prediction of future scenarios of organizational development, the achievement and consolidation of competitive positioning. Assumed as main objective of the application of a Big Data approach in the IC organizational strategy, the process of value creation results at the top of the convergence of data, approaches, tools related to the organizational ecosystem (Figure 2).

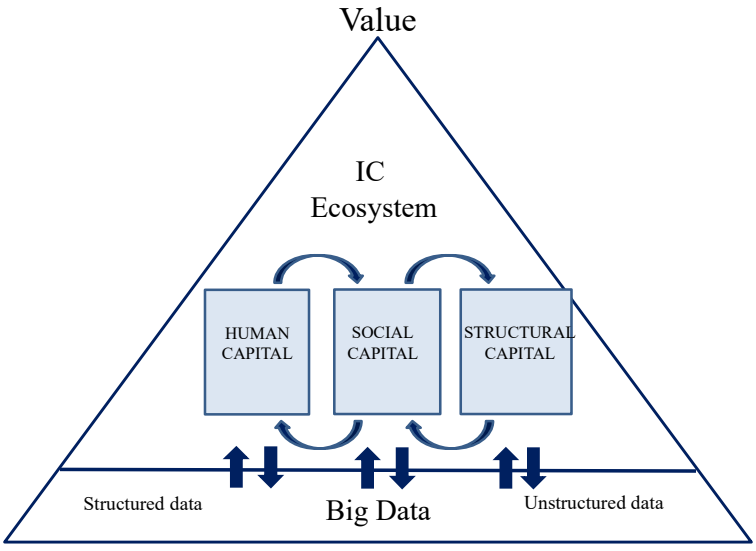

Figure 2. IC ecosystem definition through Bid Data Lens

Whatever the organizational structure, organizations will need to establish processes that promote appropriate accesses to data, address the inherent privacy and security issues, and ensure that Big Data initiatives support the IC strategic and management objectives. In the meantime, it'll be necessary to identify the different categories of actors populating the ecosystem as well as the nature, size, channels suitable to extract and collect their data.

With the aim to provide areas for future investigations resulting from the intersection of the two research streams addressing the study, in the table 1 a set of primary research questions are listed. The research questions are clustered around the four dimensions of the framework described in the previous section (figure 1).

Table 1. Setting up directions for research: the nexus between Big Data and IC

	Main Research questions
WHY:	○ What value is the organization getting from existing data analysis to improve the value generated through Intangible assets? ○ Do the board understand the potential emerging from the broader adoption of Big Data analytics for improving the development of IC? ○ Why Big Data could enhance the organizational value created through IC? ○ Why the adoption of Big Data could develop social value?
WHAT	○ What are the organizational barriers that would prevent us from implementing a more data-driven approach to IC based decision-making? ○ What impact Big Data have on the IC components? ○ Which typologies of Big data could support the interrelationship among the three components of IC? ○ Which Big data could support the creation of IC ecosystem? ○ Which Big data could create structural capital? ○ What data would we want to experiment with to see if there is predictive IC based value?
WHO	○ What areas of IC management could be aided by incorporating big data approaches? ○ Is Big Data-enabled decision-making embraced or rejected by decision-makers? ○ Who are the "crowds" of the organization contributing to the development of Big data in an IC perspectives? ○ Which are the main stakeholders creating Bid data in the organisation's ecosystem?
HOW	○ How will the organization measure value extracted from Big data? ○ How to manage Big Data for the development of IC ecosystem? ○ How Big Data could enhance IC disclosure? ○ Which Big Data processes could support IC Reporting? ○ How does the management processes and practices could foster the acquisition of Big Data for IC? ○ How to create IC through different typologies of Big Data (e.g., structured data, unstructured data….)? ○ How does the organizations could enhance the voluntary IC disclosure through Big Data? ○ How does social web technologies (LinkedIn, Facebook, Twitter,

Google+> etc..) could enhance the IC creation?
- Does my organization have the analytical and technical skills in the right functions to utilize new Big Data approaches?

As for the *Why*, main opportunities of investigations arise for a deepen comprehension of the opportunities deriving from business intelligence and Big Data analysis for the IC management, the measurement of organizational and social value resulting Big Data for the organizational IC strategy.

About the *What*, the identification of organizational barrier to the effective implementation of a IC strategy based on Big Data, their impact on the single component of IC (human, social and structural capital) toward its ecosystem configuration and the interrelationship among each of them, the comprehension of dynamics and boundaries of IC ecosystem, and opportunities for predictable or ex-ante evaluation of IC based value.

The dimension of *Who* suggests the opportunity of exploring additional areas of influence and collaboration in a Big Data perspective, the understanding of competitive positioning of actors in the industry, the impact of Big Data on each one of the different perspectives of value.

Finally, the *How* disclosures methodological and procedural questions related to the need of new measures, techniques, tools for processing Big Data and allowing their valorization into a IC strategy, also in consideration of the challenges associated to the growing volumes, differentiated sources and typologies, the need of filtering and retaining only data useful for the organizational goals.

5 Conclusions

The paper aimed to contribute at the debate on IC at the light of the recent paradigm of Big Data. Moving from the actuality of the Big Data issue, as emerging in the works of academics and practitioners in the field of Information System and Business Management, the paper has attempt to enlarge its comprehension and nexus in the field of IC research. As the application of Big data is at its starting point, further research on the use of Big data both in private and public organizations is needed (Chen et al., 2014).

This has been afforded in the paper moving from the comprehension of the perspectives of organizational value emerging from the literature on IC, the analysis on the

evolutionary scenario associated to debate on the IC, specifically identified into the emergence of a fourth stage and its ecosystem projection, the discussion on Big Data, with a focus on the meaning, dimensions and managerial implications of the phenomenon. The emergence of Big Data is one of the most evident meaning of the knowledge economy, where the large availability of data, their daily rate of growth together with the ubiquitous access make challengeable their management. this has suggested evidences for the primary area of inquiry of this study as resulting from the natural connection exists between IC and the burgeoning trend toward the application of Big Data and business analytics. All deal with some sort of intangible asset, be it data, information, knowledge, or intelligence, that contribute to develop new IC. By focusing on the strategic aspects of developing and protecting knowledge, we can get a better sense of when and how Big Data might fit into our conception of how intangible assets can benefit an organization. There is a request for scholars to look closely at how data are currently being used and assess the degree to which it can be transformed in organizational value in the forms of intangible assets and IC. And as stated by Fosso Wamba et al. (2015, pp. 234,235) "very few empirical studies have been conducted to assess the real potential of `big data´".

Those premises have allowed to identify areas of mutual exchange at the intersection of the two research streams and explore implications for the agenda of researchers and scholars in the field of IC. Based on a qualitative literature review, the study has highlighted a conceptual framework to explore the paradigm of Big Data to support the conception and execution of IC strategy. This has highlighted the perspective of value emerging in both the perspectives: Value is the most recent for the dimensions of analysis of Big Data as well the final goal, in its larger definition, of an IC ecosystem in which the organizations operate to sustaining the process of intangible assets creation and management. The deepen of those areas of intersections and mutual exchange has been schematized in the conceptual framework proposed to investigate the topic of IC management through the lens of Big Data. The Why dimension underlines the managerial motivations behind the contribution of Big Data to the fourth stage of IC research. Indeed the perspective of Big Data validate the need of shifting from an IC focus on the organization to the eco-systems perspective, more responding to a multidirectional process of knowledge and intangible assets creation to create value in terms of utility,

social value and sustainability value (Dumay, 2016). About the What, the existence of different data source and different typologies of data allow to increase the volume of data to be used for generating intangible assets and IC. As for the Who, Big Data are available and can be generated by and about all the stakeholders, inside and outside the organization, to include the volume of data generated within the eco-system. Finally, the How, showed as Big Data can represent a fruitful perspective to sustain the challenges associated to the IC management for their translation into organizational value through the adoption of the typical process of data management and business analytics.

Furthermore, moving from the investigation of the effects and implications that Big Data can offer at the advancement of the fourth stage of research on IC, and largely at the consolidation of its research agenda, threefold practical implications can be identified in terms of inferring the socio-economic value of that huge amount of data available for, from and about the organisation' ecosystems; understanding of how the connections more data oriented, between the inside and the outside IC of an organization are made; and managing Big Data as new tools supporting the disclosing and managing of IC organizational value drivers.

The four dimensions of the framework (*Why, What, Who and How*) have addressed the identification of emerging research questions. By highlighting the actuality of the two research streams and confirming the opportunity of their mutual contributions for the achievement of main research goals, the research questions provided in the last paragraph encourage the major deepening and the exploration of methodologies, technologies and processes. This is expected to open up the black box in the "data enabled organisations" (Baumgarten and Dickstein, 2013) where the practices of Big Data are exploring innovative challenges for the IC management and disclosure.

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Authors' Bibliographical Notes

Giustina SECUNDO is Senior Researcher in Management Engineering at University of Salento (Italy). Her research is characterized by a cross-disciplinary focus, with a major interest towards Knowledge assets management, Innovation Management and Knowledge intensive entrepreneurship. She has been scientific responsible of several education and research projects held in partnership with leading academic and industrial partners. Her research activities have been documented in more than 110 international papers. Her research appeared in *Journal of Intellectual Capital, Knowledge Management Research & Practices, Measuring Business Excellence, Journal of Management Development, Journal of Knowledge Management.* She's lecturer of Project management at the Faculty

of Engineering of the University of Salento since 2001. She is a member of the Project Management Institute. Across 2014 and 2015 she has been visiting researcher at the Innovation Insights Hub, University of the Arts London (UK). She can be contacted at: giusy.secundo@unisalento.it.

Pasquale DEL VECCHIO, PhD, is a Researcher and Lecturer at Department of Engineering for Innovation of the University of Salento, Italy. In 2007 he was a visiting PhD student at Center for Business Intelligence of MIT – Sloan School of Management where he had the opportunity of consolidating the methodological framework of his thesis entitled "CRM 2.0 and Reputational Dynamics in the Blogosphere. Lessons learnt from a Software Firm Case Study". His research field concerns the issues of user-driven innovation and open innovation with a specific focus on the phenomenon of virtual communities of customers. Currently, he is involved in a project related to the development of a tourist integrated system for the regional smart specialization as well as in a research venue focused on technology driven entrepreneurship. These research activities have been documented in about 40 publications in international journals, conference proceedings and book's chapters. He can be contacted at: pasquale.delvecchio@unisalento.it

John DUMAY is an Associate Professor in Accounting at the Macquarie University, Sydney. Originally as a Consultant he joined Academia after completing his award winning PhD in 2008. John's research specialties are intellectual capital, knowledge management, non-financial reporting, management control, research methodologies and academic writing. John has published over 50 peer reviewed articles in leading academic journals. He is also on the Editorial Board of Advice of eight accounting journals including the Accounting, Auditing and Accountability Journal, is the Australasian Editor of the Journal of Intellectual Capital and the Editor of the Electronic Journal of Knowledge Management.

Giuseppina PASSIANTE is full professor at the Department of Engineering for Innovation - University of Salento (Italy). She leads the public-private research laboratory named X-Net.Lab whose researchers have been involved in several projects funded by the EC under FP6 (DBE, OPAALS) and FP7 (SECURE SCM, CRESCENDO) as well as by the Italian Ministry of Research (TEKNE, MED.NET). Currently, her research fields concern the e-Business management, and more specifically the management of learning organizations and learning processes in the Net-Economy. Her focus is mainly on the development of Intellectual Capital, both in the entrepreneurial and in the academic organizations. She is also expert in development of local systems versus information and communications technologies, ITs and clusters approach, complexity in economic systems. In these research fields she has published several books and about 100 papers. Prof. Passiante is also a Member of the Independent Evaluation Committee (OIV) of the Italian National Research Council (CNR).