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Value Creation during Fourth Industrial Revolution: The Use of Intellectual Capital and Big Data

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Abstract
Intellectual capital is gaining increasing attention, especially through the adoption of innovative technologies such as big data. Literature has scrutinized the impact of big data and intellectual capital independently, and reveals a positive influence on the value of business from their utilization. Nevertheless, relying on the theory of based-view resource and the experience of practitioners in the field, this study proposes that the effects of their complementary and shared utilization should be much bigger. Such a proposal has not been discussed and empirically examined so far. This paper discusses how to deploy big data and intellectual capital concurrently in the framework of information systems, with a discussion of the interaction of big data and intellectual capital as resources that could pull out the most complementary value for companies and establish a future research agenda.

Keywords: *Big data; Intellectual Capital; Resource Based View; complementarity*

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I. Introduction

In the era of the fourth industry revolution, companies attain many resources to show more information for the creation of business value. Big data is considered to be one of the most recent buzzwords in business, acknowledged to offer "significant economic and social benefits to both individuals and companies" (Le Roux, 2012). The important advancement made in analytics (Le Roux, 2012), the capability to store big volumes of data (Waschke, 2012) and the minimized costs of data storage (Brown-Liburd et al., 2015) all contribute to the significance of Big Data for enterprises. Although the term Big Data has been widely used, its definition has been debated among scholar as well as researchers (Gandomi & Haider, 2015). For instance, it has been defined as the huge amounts of data obtained from a big number of sources, among which procurements in stores, the accounts of social media, maps, web pages, the feedback of customers, protocols, the records of health, pictures as well as videos downloading, and geographic sites in applications (Secundo et. al, 2017). However, it is defined as "the result of the systemic interaction of factors that form organization ecosystems, and which they, in turn, contribute to shaping", resulting from "the current social, economic, and technological environment", where Big Data is produced everywhere and by everything.

Besides, Big data generates fresh opportunities and values for Intellectual Capital (IC), that offer value for enterprises as well as their extensive ecosystems (Secundo et. al, 2017). The applications of Big Data are currently receiving much more attention from organizations all over the globe due to their potential to offer fresh opportunities in IC to manage and generate knowledge. Furthermore, Dumay and Garanina (2013) argued that IC has been viewed differently and has gone through a constant development over the IC research transformational stages. More recently, Dumay (2016) has modified the IC seminal definition so as to shed some light on its role in producing values. According to him, IC can be defined as the number of all things that someone in an enterprise knows that provides it with a competitive edge. Dumay (2016) also applauded that the intellectual capital can be viewed as knowledge, intellectual property, intellectual material, experience, information which could be employed to generate value.

It is widely known that Big Data has been regarded as a fresh source of business value. In this respect, La Torre et al. (2018) contended that Google, which achieved its success depending on the collection, employment, and the sale of data created by everyone and everything, is one of the international enterprises with the greatest market cap. Nevertheless, employing the advantages of Big Data relies on the capability of the enterprises to leverage this chance; there has been an increase in the awareness of challenges which encounter enterprises among which the cultural factors, technology and individuals (Baumgarten et al., 2013; Alharthi et al., 2017).

According to the resource based view (RBV), there exist five techniques to leverage resources for competitive benefits, namely, recovery, concentration, conservation, complementarity and accumulation (Hamel

& Prahalad, 1993). The influence through complementarity ways which various potentials and resources are combined to generate fresh skill amalgamation which proliferate every component value (Hamel & Prahalad, 1993; Lengnick-Hall et al., 2004). Literature (e.g. Xu et al. 2006; Hsu 2013) refers to such an interaction as incorporating complementarity and combination (Grabski & Leech, 2007; Fakoya & Poll, 2013). In this connection, the term complementarity will be used throughout the present study. In fact, the notion complementarity is considered as a resource enhancement with which it does better than working alone. Therefore, complementarity could be defined as a network or configuration of resources of properties, and this in turn entails that there could be a particular association between the resources.

The value of Big Data to IC can be noticed in the capability of an organization to convert huge number of volumes and kinds of data into knowledge which is beneficial for taking business decisions (Secundo et al., 2017; La Torre et al., 2018). Consequently, enterprises often aim to influence the Big Data value by the value for their IC and obtain a reasonable edge. Therefore, IC management usually addresses the ways of managing and leveraging fresh knowledge sources offered by Big Data. However, new obstacles encounter IC accounting as a resurging topic for practitioners as well as researchers particularly with regard to the environment of the Big Data. Therefore, the notion describing Big Data has developed a fresh stimulus for revisiting and analyzing the IC future. This raises the question of the extent to which the present practices for IC complementarity to leverage Big data could assist in understanding the development of the optimal value of Big Data.

Consequently, the current study attempts to analyse the association between IC and Big data from various perspectives in respect of offering the Big data benefits connected to IC as complementarity sources to generate the creation of business value. In particular, it reviews the current literature on Big Data as well as IC so as to present fresh insights into the obstacles of reporting and measuring IC in the Big Data era. The study is organized as follows: Section 2 provides a review of past Big data as well as IC literature for the purpose of synthesizing the motivations for its loss of interest and the necessity for a renewed significance within the Big Data context. Besides, Section 3 provides the model of the research as well as hypotheses according to the resource based view theory based on which the study examines how the determinants underpinning IC, Big Data, and their complementarity assist in creating business value. Lastly, Section 4 provides the discussion and conclusions of the present study.

II. Literature Review

Intellectual capital business value

IC is a thriving and well-established research domain. However, it has been constantly evolving (Guthrie et al., 2012). In this regard, Dumay and Garanina (2013, p. 169) argued that IC has been viewed differently and has gone through a constant development over the IC research transformational stages. More recently, Dumay (2016) has modified the IC seminal definition aiming to shed light on its role in generating values. According to him, IC can be viewed as number of all things somebody in an enterprise knows that it provides it with a reasonable edge. In fact, intellectual capital includes material, intellectual property, experience, knowledge, information that could be utilized to generate values (Dumay, 2016, p. 169).

The significance of the sources of knowledge has promptly increased in several fields including strategic management, economics, and accounting (Davison, 2014). IC is a component which is necessary for creating value in enterprises (Moustaghfir and Schiuma, 2013).

It is claimed that the information of intellectual capital is a significant driver of companies (Xiao Huafang & Wan Wenzhong, 2009). The revelation of the information of intellectual capital cannot just communicate the business strategy of a company to the outside world, but also decrease the asymmetry of information. In this respect, Ran Qiuhong et al. (2007) investigated the content of the information of non-monetary measured intellectual capital revealed by 223 listed enterprises in 2005, and calculated the information of intellectual capital assessed by money. The analysis revealed that the intellectual capital has positively created the organizational performance. Besides, Kamath (2017) listed information of National Stock Exchange (NSE) for a period of six years, from 2007 to 2013, utilizing 165 export firms and argued that the export performance as well as productivity of all enterprises are considerably affected by intellectual capital and particularly the human capital. Furthermore, Yilmaz and Acar (2018) pointed out that intellectual capital significantly and positively affect the financial performance that develops the enterprises' value. In addition, Sullivan (1998) maintained that intellectual capital is comprised of knowledge-based resources that contribute to the sustained competitive advantage of the firm. To sum up, intellectual capital includes the main firm-specific insubstantial resources which generate values for the enterprises and it is also hard, if not absolutely impossible, to reproduce (Teece, 1998; Nonaka, Toyama, & Konno, 2000).

Previous research that is relevant to value creation as well as intellectual capital has revealed that this domain is still in its infancy. Therefore, this study is an attempt to generate enterprise values utilizing an amalgamation of intellectual capital as well as Big Data.

Big data and business value

Big data is an area of emergent relevance into the researchers as well as scientists' agenda (Gandomi and Haider, 2015). Laney (2001) claimed that this term refers to any set of data which, with outdated systems, needs a long period of time to be examined. The creation of Value in a Big Data perspective forms the economic dimensions and conventional monetary of value, to comprise the complete value from the insubstantial assets and knowledge (Secundo, Del Vecchio, Dumay, & Passiante, 2017). Because of its ability to offer a big and varied data to firms and organization from which it is potential to obtain important insights (Morabito, 2015) about customers' needs, perferences, attitudes, views and so forth (Canhoto & Clark, 2013; Choudhury & Harrigan, 2014), Big Data has been considered as a significant source of the creation of value.

Value from the analysis of Big Data can be stated in the obtained knowledge for supply segmentation, fresh business models, performance improvement, new development of products, better decision making, and supply customization (Schadt, Linderman, Sorenson, Lee, & Nolan, 2010; LaValle, Lesser, Shockley, Hopkins, & Kruschiwtz, 2011; Griffin, 2012; Davenport, Barth, & Bean, 2012; Mcafee & Brynjolfsson, 2012; Wagner, 2012). Besides, other studies revealed the Big Data role in sustaining the innovation of products (Mayer-Schönberger & Cukier, 2013) and the predictive activity of firms (Kaisler, Armour, Espinosa, & Money, 2013). Fosso Wamba, Akter, Edwards, Chopin, and Gnanzou (2015) carried out a recent comprehensive review of the relevant literature of the business value of Big Data among 234 journal articles in Big Data published in the time from 2006 to 2012; they systematized and synthesized the key sources of value creation resulting from Big Data, encompassing 5 main types of value creation: 1) Creating transparency; 2) Enabling experimentation to discover needs, expose variability and improve performance; 3) Segmenting populations to customize actions; 4) Replacing/supporting human decision making with automated algorithms; 5) Innovating new business models, products and services. Overall, the main characteristics of Big Data paradigm have been identified into the large size of dataset (terabyte and more), the presence of structured and unstructured data, the short life-cycle of contents (Laney, 2001), while converting unstructured data into structured numbers is now mandatory to transform the huge amount of data created over the world into organizational value.

The studies demonstrate that Big Data can significantly enhance organizations' value creation, Accordingly, Big Data offers several opportunities associated challenges arises However, while it is largely recognized the relevance of the paradigm, how to transform all those data in tangible or intangible assets is still missed (O'Neil and Schutt, 2013; Jin et al., 2015). Consequently, the current study will try to create business value from different perspective of previous studies using the complementarity role of Big data and IC and that might be a proper way to transform data to tangible and intangible assets.

Theoretical background: Resource complementarity in RBV

The Resource-Based View (RBV) argues that firm resources are heterogeneously distributed across firms. When the firm resources are valuable, rare, imperfectly imitable, and non-substitutable, they could create competitive advantages, which in turn could explain the differences in firm performance (Barney, 1991; Grant, 1991; Wernerfelt, 1984). Moreover, resources tend to survive imitation because of isolating mechanisms such as history dependence, causal ambiguity, and social complexity (Barney, 1991). The RBV (or its variations) has been applied by information system (IS) researchers to analyze the business value of IT (see Wade & Hulland, 2004 for a review).

A resource is a term that has been frequently used in the RBV theory and it can be tangible and intangible (Big data and IC). Resources are inputs into a firm's production process, such as capital, equipment, information systems, and individual employees. Most previous studies based on the RBV posit a direct relationship between IT resources and firm performance (Bharadwaj, 2000; Mata et al. 1995; Rindskopf & Rose, 1988). More recently, some researchers have emphasized that the IT resource is likely to affect firm performance only when it is deployed to create unique "complementarities" with other IT or other firm resources (IC) (Bharadwaj et al., 2007; Rai et al., 2006).

Complementarity represents an enhancement of resource value and arises when a resource produces greater returns in the presence of another resource than by itself (Milgrom et al., 1991). Resources rarely act alone in creating or sustaining competitive advantage, and this is particularly true of IT resources that, in almost all cases, act in conjunction with other firm resources to provide strategic benefits (Wade & Hulland, 2004). IT-based success rests on the ability to "fit the pieces together" complementarily (Ravichandran & Lertwongsatien, 2005).

Borrowing the same idea (refer to Fang Hsu, 2013), complementarity between IT resources make it more possible for firms to achieve competitive advantage than one resource alone.

Based on the RBV literature the study proposes two explanations for the role of complementarity in IT context. First, in general, physical technology such as a complex information system such as Big data, by itself is typically imitable. If one firm can purchase these physical tools of production, then other firms should also be able to purchase these physical tools, and thus such tools should not be a source of sustained competitive

advantage (Barney, 1991). On the other hand, if a firm can exploit physical technology involving the use of socially complex firm resources, the synergies among them are far more difficult to imitate (Barua et al., 2004; Zhu, 2004). Several firms may all possess the same physical technology, but only some of these firms may possess the social relations, culture, traditions, etc. to fully exploit this technology in implementing strategies (Barney, 1991).

Therefore, complementarily leveraging resources is considered a firm-specific capability (Grant, 2002). Numerous studies have commented that integrating IT resources (systems) to build a flexible and sophisticated IT infrastructure requires both considerable time and expertise (Ravichandran & Lertwongsatien, 2005). Although the individual components that go into the infrastructure are commodity-like, the process of integrating the components to develop an infrastructure tailored to a firm's strategic context is complex and imperfectly understood (Bharadwaj, 2000).

Complementarity of Big data and Intellectual Capital

Big Data is under the spotlight in many research fields and is gaining momentum in IC research as well (Secundo et al., 2017). Secundo et al. (2017, p. 242) provide an understanding and a conceptualization of Big Data and IC by outlining the "socio- economic value of Big Data generated by and about organizational ecosystems". "Big Data and business analytics" can bring "new capabilities to organizational value creation" and support new intangible assets, the authors call for a need to discuss "how they fit within the IC universe" (Secundo et al., 2017, p. 251). Big Data has several advantages for IC and IC management. However, the risks related to Big Data phenomenon have not yet been adequately explored and very few management and accounting studies have investigated data security, data breaches and their effects on organizations. However, utilizing the benefits of Big Data depends on an organization's ability to leverage this opportunity and there is an increasing awareness of the barriers facing organizations related to people, technology and cultural factors (Alharthi et al., 2017; Baumgarten et al., 2013).

Secundo et al. (2017, p. 247) state that Big Data "creates new value and new opportunities for IC management", which provide value for organizations and their wider ecosystems. In their framework, the authors conclude that the value gained from Big Data is coherent with the IC strategic objectives "to move beyond IC's monetary value and find organizational wealth in more general terms", by promoting a more equal and inclusive society, organizational transparency, continuous innovation, and better decision making" (p. 249). However, Big Data's potential impact is neither immediate nor easy to achieve. Data has no intrinsic value alone and neither the volume nor velocity of data can create a competitive edge, since "the potential value of Big Data is unlocked only when it is leveraged to drive decision making" (Secundo et al., 2017, p. 249; 251) and that could be achieved with Bid data combined with IC. Hence, although Big Data has several implications and potential impacts in different contexts, its source of competitive advantage needs to be analyzed with the combination of IC as complementarity resources.

Wang et al. (2016, pp. 750-751) argue that "decisions are made by deriving information from data, obtaining knowledge from information and then achieving wisdom from knowledge" to finally gain competitive advantage. As more decisions become strategic and systemic in this process (for example in transforming insights into organization knowledge), so too is the human factor becoming more crucial in providing valuable insights from that data to create knowledge. The combination of Big data and IC means not only technology that plays important role, but also the human factor which is as equally important. The acceptance of employees to use the technology is represented. At the same time, what should also be in consideration is the complexity of social processes and their importance in promoting collaboration should be considered (Warfield 1989).

The human factor represents a significant non-technical challenge for Big Data. Alharthi et al. (2017) argue that, in addition to the technological challenges, there are important organizational and human barriers for Big Data initiatives. These include the lack of a proper organizational culture and, on the human side, the need to develop Big Data skills. The main challenge of Big Data is "to support human analysts and managers to make quicker decisions" based on reliable and valued information, and this entails the need to develop technologies that can enhance the interaction between data and users (Wang et al., 2016, p. 760). Accordingly, this highlights the need to improve the interface between analytics and human cognition by addressing the challenge of "visualisation", i.e. the ability to represent knowledge and facilitate human understanding (Assunção et al., 2015, p. 10; Yaqoob et al., 2016, p. 1244). Thus, despite its technological roots, Big Data highlights the importance of the human dimension, which may also be its doom if not properly addressed. As result, Big data and IC need to work hand in hand and complement each other as one variable to lead to create the expected business value.

Although research attention has predominantly focused on the technological aspects of Big Data, over time, Big Data is revealing the importance of its human and social implications. As argued, Big Data reshapes organisations' IC. This implies the need to connect and align Big Data technologies with human capital. The compelling need to make organisations ready for the Big Data era is pushing them to revise and reshape their

human capital (Baumgarten et al., 2013). Big Data's value to IC lies in an organisation's ability to transform enormous volumes and types of data into knowledge that is useful for business decisions (Secundo et al., 2017; La Torre et al., 2018). Accordingly, companies want to leverage the value Big Data brings to create value for their IC and gain a competitive edge. Thus, IC management is addressing how to manage and leverage new sources of knowledge provided by Big Data. Yet, new challenges rise up for IC accounting as a resurging topic for researchers and practitioners.

This study is a response to the call to examine Big Data by complementing it with IC as one main variable to create business value and competitive advantage. By this, it contributes to understanding how Big Data can deal with IC practice. Thus, the paper use RBV theory to leverage company resources by the complementarity in the era of Big Data and its implications for IC as a way of introducing this topic to accounting research and to provide avenues for future research. Our intent is not to address any technical specificities, which are the preserve of other fields, but rather to offer new perspectives for Big Data as a managerial paradigm and to consider its critical implications for firms.

III. Research Model and Propositions

Since the RBV provides the rationales to explain complementarity, and previous literature explain the complementarity relationship between Big data and IC. As result, this study proposes corresponding research model to investigate Big data, IC, and their complementary effect on business value. The model represents firm resources which considered complementary when the presence of one resource enhances the effect of another resource. This interaction perspective of complementarity is typically operationalized using multiplicative terms in statistical analysis (Hsu, 2013). Based on the proposed literature, a research model will be illustrated in Fig. 1.

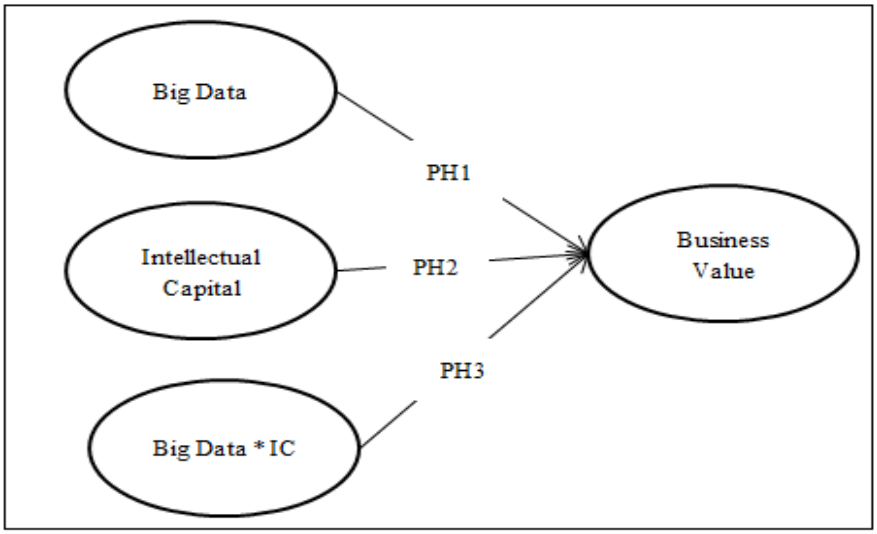

Fig. 1 Research Model

Hypothesis Development

Wamba et al. (2015) emphasized that the main source of value creation resulting from Big data. The studies demonstrate that Big Data can significantly enhance organizations' value creation (O'Neil and Schutt, 2013; Jin et al., 2015; Rehman et. al, 2016; Saggi & Jain 2018). Additionally, other studies demonstrate the role of Big Data in sustaining product innovation (Mayer-Schönberger & Cukier, 2013) and firms' predictive activity (Kaisler, Armour, Espinosa, & Money, 2013). Secundo et al. (2017, p. 247) state that Big Data "creates new value and new opportunities for IC management", which provide value for organizations and their wider ecosystems. Accordingly, this study proposed that:

Proposition 1: Big *data is essential and positively influence business value creation.*

Ran Qiuhong et al. (2007) indicated that intellectual capital has positive impact on organizational performance and that positively related with business value creation. Kamath (2017) found out that productivity and firm performance which created business value highly influenced by intellectual capital. Additionally, Yilmaz and Acar (2018) their study result that IC has significant positive effect on financial companies performance. Therefore, the study proposes the following:

Proposition 2: *Intellectual capital is essential and positively influences business value creation.*

Big Data analytics, whether predictive, descriptive or prescriptive (Chen et al., 2012, p. 1182) and however produced (Wang et al., 2016, p. 756), are designed for human intelligence – people have to use and apply the results. Accordingly, IC gains significance in such a process. Petty and Guthrie (2000, p. 157, 159) In their study on IC, observe that IC "is implicated in the process of leveraging and developing organizational knowledge" and knowledge management exists in the act of managing the IC controlled by a company. Secundo et al. (2017, p. 251) argue that Big Data can bring new capabilities to organizational value creation, but there is a need to unlock the value of Big Data. IC management is a way of unlocking Big Data's value, but it depends on certain IC assets. In particular, organizations must be able to create knowledge from that data and then convert it into value. In addition, McAfee and Brynjolfsson (2012) state that before seeing a beneficial impact from Big Data on management and performance, companies must first revolutionize the culture surrounding their organizational decision-making processes. In the context of Big Data, it is human capital that provides valuable insights and knowledge from data. Organizations need to face the challenge of re-shaping their human, relational and structural capitals to allow IC management to capture Big Data's value. This means changing people's skills, approaches to innovation and change, the organizational culture, internal procedures, information systems and decision-making processes. Therefore, while we agree that Big Data is a valuable source of IC for organizations, our concerns rest with the challenges organizations still need to address to increase the value of their intangible assets. However, Big Data's potential impact is neither immediate nor easy to achieve. Data has no intrinsic value alone and neither the volume nor velocity of data can create a competitive edge, since "the potential value of Big Data is realized only when it is leveraged with IC to drive decision making" (Secundo et al., 2017, p. 249; 251). Accordingly, the following proposition has been proposed

Proposition 3: *Big data, intellectual capital and their complementarity is essential and positively influences business value creation.*

IV. Conclusion

Enterprises worldwide are facing increasing competition in the knowledge economy era. To be competitive and successful, it is imperative for enterprises to renovate their resources such as Big data and integrate it with intellectual capital. Future generation big data with intellectual capital will be more responsive to the changes in global business environment and can create an optimal business value. Based on the RBV theory and previous literature, the explanations for the role of complementarity in IS context are postulated. As a result, implementing both big data and intellectual capital is highly desirable. From enterprises' point of view, big data and intellectual capital should be integrated for competitive advantages. Due to the fact that the objectives and characteristics of big data and intellectual capital are different to each other, the integration involved is a complicated process. The paper discusses the issue of jointly implementing big data and intellectual capital.

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