The fall and rise of intellectual capital accounting: new prospects from the Big Data revolution

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Abstract

Purpose: As Big Data is creating new underpinnings for organisations' intellectual capital (IC) and knowledge management, this paper analyses the implications of Big Data for IC accounting to provide new conceptual and practical insights about the future of IC accounting.

Research design: Based on a conceptual framework informed by decision science theory, we explain the factors supporting Big Data's value and review the academic literature and practical evidence to analyse the implications of Big Data for IC accounting.

Findings: In reflecting on Big Data's ability to supply a new value for IC and its implications for IC accounting, we conclude that Big Data represents a new IC asset, and this represents a rationale for a renewed wave of interest in IC accounting. IC accounting can contribute to understanding the determinants of Big Data's value, such as data quality, security and privacy issues, data visualisation and users' interaction. In doing so, IC measurement, reporting, and auditing need to keep focusing on how human capital and organisational and technical processes (structural capital) can unlock or even obstruct Big Data's value for IC.

Research implications/limitations: The topic of Big Data in IC and accounting research is in its infancy; therefore, this article acts at a normative level. While this represents a research limitation of our study, it is also a call for future empirical studies.

Practical implications: Once again, practitioners and researchers need to face the challenge of avoiding the trap of IC accountingisation to make IC accounting relevant for the Big Data revolution. Within the euphoric and utopian views of the Big Data revolution, this article contributes to enriching awareness about the practical factors underpinning Big Data's value for IC and foster the cognitive and behavioural dynamic between data, IC information and user interaction.

Originality: This article aims to instil a novel debate on Big Data into IC accounting research by providing new avenues for future research.

Keywords:

Big Data, intellectual capital, intellectual capital accounting, privacy, data security, visualisation, data quality.

1 Introduction

Big Data is one of the latest buzzwords in business, touted to bring “significant economic and social benefits to both individuals and companies” (Le Roux, 2012). Reduced data storage costs (Brown-Liburd *et al.*, 2015), the ability to store increased volumes of data (Waschke, 2012) and significant progress made in analytics (Le Roux, 2012) all contribute to Big Data’s rising importance for companies. Big Data applications are attracting increasing interest in organisations for their potential to open up new opportunities in IC to create and manage knowledge.

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.

The attempt of creating standards, guidelines and frameworks for measuring and reporting IC has been the main research topic of second stage IC research (Dumay, 2013, p. 5). As argued by Petty and Guthrie (2000), after establishing awareness of IC in the first stage, a second stage of research made IC visible, by addressing how IC “should be measured and reported” to understand its economic value (pp. 160-162). As Big Data is structurally changing the conditions underpinning the value of organisations’ IC and knowledge (see Secundo *et al.*, 2017), we question its implications for the future of IC accounting.

Knowledge-based companies have had a prominent role in the economy in the last three decades, which has increased the importance of IC for organisations. Dumay (2009, p. 191) highlights that one of the structural changes underpinning the affirmation of a knowledge-based economy is the recognition of knowledge as a commodity to be utilised in transactions. To date, Big Data ecosystems have created new structural changes for the modern knowledge-based economy, resulting in a shift to a data-based economy – data has become a transactional commodity (McFarland *et al.*, 2015). La Torre *et al.* (2018) state that “Big Data is the result of the systemic interaction of factors that form organisation ecosystems, and which they, in turn, contribute to shaping”, as a result of “the current social, economic, and technological environment”, in which Big Data is generated by everything and is everywhere. This new scenario poses new questions about how IC is (or should be) measured, managed and disclosed.

The fact that Big Data represents a new source of business value is not surprising. For example, Google, which built its success relying on collecting, using and selling data generated by everything and everyone, is one of the global companies with the highest market cap. Yet, Big Data and the digital ecosystem overall also pose new threats to business and IC, which arise from cybersecurity risks and data breach threats (La Torre *et al.*, 2018). As reported in Fortune, after Yahoo disclosed their massive data breach in 2016 – the biggest one in history – their shares fell more than 7% (Reuters, 2016). The U.S. Securities and Exchange Commission received a request to investigate whether "Yahoo had fulfilled obligations to inform investors and the public about it", because, as Senator Warner stated, "if a breach occurs, consumers should not be first learning of it three years later" (Reuters, 2016). Thus, the phenomena characterising Big Data has created a new stimulus for analysing and revisiting the future of IC accounting. This calls into question whether the current accounting practices for IC can help us to understand the value and risks of Big Data.

In response to this call, we analyse the new underpinnings for the future of IC accounting. Specifically, we review the recent literature on IC, accounting and Big Data to provide new insights into the challenges of measuring, reporting and auditing IC in the era of Big Data.

The paper is structured as follows. Section two reviews past IC accounting literature to synthesise the motivations for its loss of interest and the need for a renewed importance within the context of Big Data. Section 3 presents the framework based on decision science theory through which we analyse how the determinants underpinning Big Data's value affect IC measurement, reporting and auditing. Finally, section 4 presents our final reflections for IC accounting practice and research along with our conclusions.

2 IC accounting: past and future perspectives

2.1 The fall of IC accounting

Over time, IC research has gone through several evolutionary stages. In their seminal paper, Petty and Guthrie (2000, p. 162) state that, after its first stage of development, aimed at creating awareness of IC's relevance, the second stage of IC research takes the position that "intellectual capital is something significant" and, therefore, "should be measured and reported". Since then, IC accounting research has been focused on developing frameworks and methods for evaluating and reporting IC (Guthrie *et al.*, 2012; Osinski *et al.*, 2017). By this, measuring and reporting represent the two main and complementary activities of IC accounting. The latter, however, differs from "intangible accounting", which instead is limited to only IC elements recognised by traditional financial statements (Guthrie *et al.*, 2012).

Understanding the need to measure and manage IC dominates practice and research. Andriessen (2004, p. 232) explains that the numerous frameworks proposed to evaluate and measure IC (or even measuring its monetary value) relies on the "what gets measured gets managed" rationale. Similarly, "closing the value gap between book and market value" and "reducing information asymmetry" motivate many IC reporting models (Andriessen, 2004, p. 234). These two economic theories have been debated and used to justify the inadequacy of financial reporting for a long time and inspired a long wave of IC accounting research.

Over time, much IC research has focused on IC reporting and disclosure (see Guthrie *et al.*, 2012), claiming the need to provide information about how intangible resources can create future value and communicate knowledge-based strategies to the capital market (Roos and Roos, 1997; Mouritsen *et al.*, 2004). However, the insights from the recent literature are not optimistic about the future of IC accounting, and IC reporting in particular (Dumay and Cai, 2014; Cuozzo *et al.*, 2017).

Dumay (2016, p. 132) states that the year 2012 signifies the death of IC reporting, "at least from a listed company perspective", which is demonstrated by the low adoption of IC reports. Schaper (2016, p. 52) concludes that several reasons affected companies' decisions to abandon IC statements in Denmark, but the most common one is the "low perceived value of IC statements, both internally from a knowledge management perspective and externally in relation to the disclosure practice". In their literature review, Cuozzo *et al.* (2017, p. 20) demonstrate that "IC disclosure research in its current form is arguably petering out" and losing impact. Such a lack of interest in IC accounting reveals not only how this research field has been the victim of its own success (Dumay and Guthrie, 2017), but also represents the need to open IC accounting to new research avenues and practical innovations (Dumay, 2016).

2.2 Reviving issues for IC accounting

It is worth noting that two major phenomena are currently leading the IC accounting debate: first, the emergence of Integrated Reporting (Dumay *et al.*, 2016); and, second, the established debate on its business model (Beattie and Smith, 2013). Indeed, IC inspired most of the conceptual base of Integrated Reporting and the fact that this gained great attention by IC scholars is not surprising. Similarly, within the established debate on accounting for intangible assets, "the business model concept offers a powerful overarching concept within which to refocus the IC debate" (Beattie and Smith, 2013, p. 243). Big Data, along with its broad technological and digital grounds, represents another factor affecting IC accounting.

In a recent article in the Harvard Business Review, Govindarajan *et al.* (2018) argue that traditional financial accounting information does not work well for digital companies. This is due to intangible investments – e.g., brands, organisational strategy, networks, customer and social relationships, computerised data and software, which, despite being higher than their physical assets, are not represented in the financial statement (Govindarajan *et al.*, 2018). This, again, creates a focus on the debate of measuring and reporting IC, along with the taken-for-granted role of IC to explain the gap between companies' book value and market value (see for example Mouritsen, 2003; Nielsen *et al.*, 2006; Dumay, 2009).

In providing projections for the future of financial reporting, Barth (2018) states that the issue of representing intangible assets into accounting information is not new, yet "fixing the problem never seems to get traction" (p. 7). This calls to refocus the debate on providing information that "help investors assess the value of intangible assets" (Barth, 2018). Despite this resurging old need (or "fixation") "for developing accounting for IC" (Dumay and Rooney, 2011, p. 344), to explain firms' value in a digital economy, Govindarajan *et al.* (2018) assert that the answers are not yet clear and "it is unlikely that accounting standards will change in the near future to allow digital companies to capitalize their intangible investments". Within this context and the current digital ecosystem, Big Data is a new central piece of the current debate on understanding the value of companies' intangibles resources and IC.

Big Data is attracting the accounting community by projecting new scenarios about the changes for accounting and auditing practices (e.g. Vasarhelyi *et al.*, 2015; Warren *et al.*, 2015; Appelbaum *et al.*, 2017a; Borthick and Pennington, 2017). Warren *et al.* (2015) assert that Big Data can finally help to understand and evaluate firms' intangible assets, which have been, so far, a limitation of financial accounting practices. However, Big Data does not only offer new methodological and analytical techniques to analyse and assess, so overcoming what was previously impossible to do. Indeed, the use of Big Data also represents a new asset for organisations and has prime implications for organisations' IC. Its value directly benefits organisations' IC in generating and managing knowledge (Secundo *et al.*, 2017). Therefore, due to the need for understanding and managing such a new source of value, Big Data is likely driving a renewed interest in accounting for IC.

3 Value and challenges of Big Data: new prospects for IC accounting?

At a theoretical level, Big Data can directly impact IC value by providing benefits in creating and managing knowledge (Secundo *et al.*, 2017). La Torre *et al.* (2018) point out that the narrow aim of any Big Data use is to enhance decision making and the capability of an organisation to transform data into knowledge and then actions. Thus, if the aim of using large amounts and sources of data through highly scalable analysis tools is to produce better information, then, to unveil Big Data's value, information should be channelled toward creating knowledge for supporting decisions.

Decision science theory helps to explain Big Data's value for decision-making and organisations. Decision science refers to the values, uncertainties, rationalities and optimal decisions permeating decision-making. As Wang *et al.* (2016) argue, decision theory theoretically supports all the phases of processing Big Data – from data extraction to data visualisation, and then to knowledge creation because every phase requires human decision making. The authors point out that "the solutions of Big Data enrich the content and scope of decision sciences", so that "one can make more intelligent and felicitous decisions by utilizing better prediction" (Wang *et al.*, 2016). Thus, from this theoretical perspective, Big Data's value relies on selecting processes (activities) and resources (human, technical and data) that specifically use and process data.

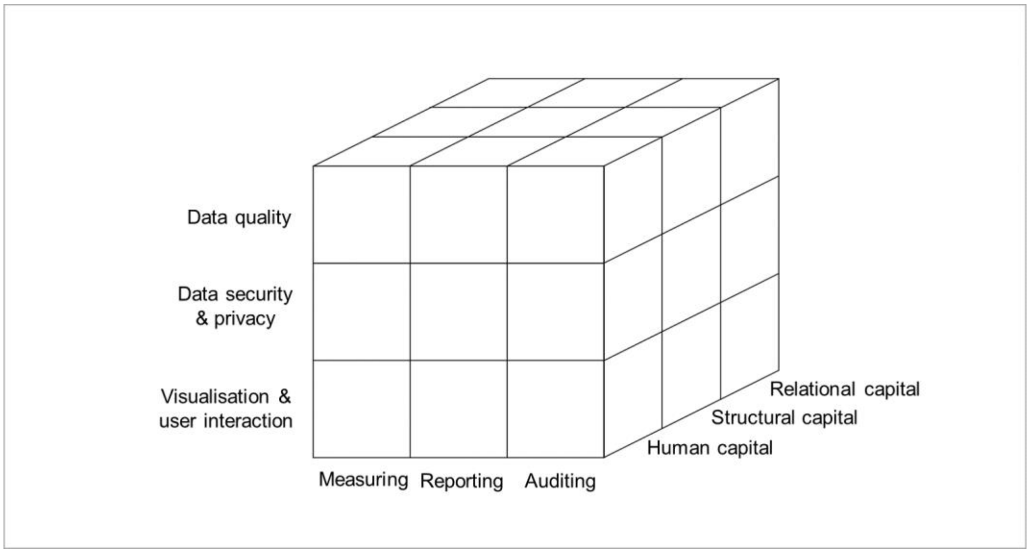
Accordingly, the recent literature identifies three factors affecting Big Data's value for, and referring to, the information governance underpinning the Big Data paradigm. These determinants are:

- Data quality (Kwon *et al.*, 2014; Akoka *et al.*, 2017).
- Data security and privacy, which relate to the process of data acquisition, storage and access and represent some of the technical and human barriers to Big Data (Alharthi *et al.*, 2017).

- Visualisation and user interaction (Assunção *et al.*, 2015).

As depicted in Figure 1, this section is dedicated to analysing the three determinants above and how they affect IC accounting. In the sub-sections below, we analyse and demonstrate how the factors of Big Data's value affect IC accounting practices (i.e. measuring, reporting and auditing) and cross the ontological components of IC (human, structural and relational capital) as it is illustrated in Figure 1.

Figure 1.Factors of Big Data value and dimensions of IC management and accounting



3.1 Data quality

Data quality is one of the most debated aspects of Big Data in academic research (Akoka *et al.*, 2017) and, with reference to the narrower technical issues, it includes the more general problems of data completeness, consistency, noise, representativeness and reliability (Kwon *et al.*, 2014; Akoka *et al.*, 2017). Data quality is a debated issue because Big Data is usually 'dirty data'. A term used to identify "missing data, wrong data, and non-standard representations of the same data" (Kim, Choi, Hong, Kim & Lee, 2003, p.81). Nowadays, data mining often relies on external sources (e.g., social media) that contain unstructured data, such as messages and comments. This implies processing heterogeneous and informal data that is produced externally and, therefore, compared to traditional business intelligence practices, Big Data is usually out of the corporation's control (Kwon *et al.*, 2014). Such a process of data acquisition requires processing data to make it representative, consistent and complete to produce relevant and reliable data analytics.

Kwon *et al.* (2014) identify two key dimensions of data quality: data consistency and data completeness. Keeping data consistent means to make "data uniform as they move across the network and are shared by various applications and systems"; data completeness "refers to the degree to which all data necessary for current and future business activities (e.g., decision making) are available in the firm's data repository" (Kwon *et al.*, 2014, p. 389). In addition to these intrinsic characteristics, there are also some contextual dimensions of data quality depending mostly on the users of data and their experience. These are, for example, accuracy, relevancy, value-added, quantity, believability, accessibility and reputation of the data (Hazen *et al.*, 2014, p. 73). These dimensions directly affect Big Data's usage and their lack represents a barrier to Big Data's benefits.

From a resource-based perspective, Kwon *et al.* (2014, p. 388) argue that both the "capability of data quality management and data usage experience constitute intangible assets (or resources) that lead a firm to higher IT capability". Accordingly, any lack of data quality discourages data-driven decision making, because "trust in data quality can be significantly impaired" due to the difficulty in assessing the business risks coming from, for example, missing and inconsistent data (Kwon *et al.*, 2014, p. 389). Therefore, data quality management represents the first barrier in using Big Data; creating a challenge for IC accounting to assess and measure Big Data's value.

3.1.1 Measuring and reporting human capital and internal capabilities for data quality perception

Measuring IC arose from a need to better understand the value of IC and the factors driving such a value. Roos and Roos (1997, p. 414) assert that setting up a system for measuring IC is a response to the question: "How can companies better visualise and even measure the growth and/or decline of IC, the 'intellectual performance' of the company?" Accordingly, in understanding how Big Data usage contributes to the organisation's IC performance, assessing the quality of data helps to understand the internal capabilities in using Big Data for decision making.

From a resource-based perspective, managing, monitoring and ensuring data quality depends on both hard and soft organisational resources. The former concerns technologies and information systems (i.e., structural capital) for managing and monitoring data, while the latter stems from human know-how, skills and expertise (i.e., human capital). There are several technical proposals for monitoring and controlling data quality (Hazen *et al.*, 2014), but managing and evaluating data quality remains a challenge in the Big Data environment (Tien, 2013). Assunção *et al.* (2015, p. 12) point out that, in performing Big Data analytics as a service, it is difficult to "measure quality and reliability of results and input data" and provide "guarantees on methods and experts responsible for analysing the data". As a result, these difficulties make measuring the intangible resources of Big Data arduous. However, data quality management is not merely a technical issue, and this opens some interesting projections for IC accounting.

In their study, Kwon *et al.* (2014, p. 387) find that "a firm's intention for big data analytics can be positively affected by its competence in maintaining the quality of corporate data" and a previous "favourable experience (i.e., benefit perceptions)" in utilising external sources of data. This means that data quality also depends on internal capabilities and experience that produce both organisational knowledge for ensuring data quality and cognitive effects on human perception about the reliability of data analytics.

Kwon *et al.* (2014, p. 388) point out that "successful experience with data usage" is an important form of human capital that becomes a "positive force in pursuing innovative big data analytics". Therefore, despite the technical difficulties in assessing and controlling data quality, IC measurement can contribute to understanding how human capital ensures data quality for reliable decision-making. By this, measuring, assessing and reporting information on people's skills, expertise and organisational know-how in data quality management help to construct trust in Big Data analytics and evaluate their value for decision making.

As measuring and evaluating IC is an opportunity to understand and get a managers' attention on IC in action (Giuliani and Marasca, 2011), then measuring human capital for data quality can improve managers' awareness of the internal capabilities and people skills involved in managing and processing data. In practice, if managers can understand how information and analytics are produced, they can rely on them more and be urged to use Big Data for decision-making. Therefore, improving trust in data quality can reduce the uncertainty about the reliability of Big Data.

3.1.2 IC auditing and data quality

Audits are typically used to transmit a positive signal to users "regarding the accuracy of management disclosures" in the financial statements so that parties can do business with confidence (O'Sullivan, 1993, p. 412). Zhao *et al.* (2004, p. 389) believe "the increasingly pervasive use of information technology and its growing power threatens the audit" profession. Auditing has borne witness to significant economic revolutions over the ages. For example, auditors were around through all the stages of maritime transport from the first sailboats to the arrival of the first steamboats in the 1800s and again when ships changed to using bunker fuel and nuclear power (Stopford, 1997). Through all these changes, auditors have always managed to benefit from the economic revolutions their clients were exposed to by altering their role in response to external events and pressure (Chandler *et al.*, 1993). The Fourth Industrial Revolution with its advances in technology is the first time in history where the auditor is no longer merely a spectator to change but the subject of the disruption.

Auditors aim to gather evidence, which enables them to express an opinion about the quality of the data they assure by performing both tests of controls and substantive tests (Messier *et al.*, 2017). As companies start to realise Big Data's value, tools are being developed that can scrutinise "complex business data" (Gow and Kells, 2018, p. 180) which makes some of the audit techniques previously used, like sampling, superfluous. The advent of these new technologies has also seen new entrants to the assurance market from competitors outside the traditional accounting and auditing firms (Gow and Kells, 2018). The realisation is starting to sink in that the IC auditors thought they could lay claim over depends "on very few proprietary technologies" (Gow and Kells, 2018, p. 177). Technology that "applies advances such as artificial intelligence, machine learning and Big data to the tasks of auditing" (Gow and Kells, 2018, p. 178) are seriously disrupting the profession's IC. Thus, the importance of human capital to the auditing profession and to an audit firm's survival means that, once again, auditors need to keep their technical skills and expertise in line with technological advances (Bröcheler *et al.*, 2004).

The auditors' own IC is not the only IC under scrutiny in the Fourth Industrial Revolution. The auditor's ability to assure IC was highlighted by the auditors themselves during a recent survey on key audit matters (KAMs). The introduction of KAMs in the audit report requires auditors to "focus on aspects of the company's financial statements that the auditor" finds most challenging (Sirois *et al.*, 2018, p. 1). This requirement highlights IC as the area auditors most frequently report under KAMs. As Guthrie *et al.* (2012) demonstrate, IC research has paid very little attention to auditing IC. However, this does not mean that auditing knowledge and IC is less important. Auditing IC is a means of providing a "detailed assessment of the state of […] IC" (Petty and Guthrie, 2000, p. 161). Therefore, when Big Data provides value to IC, the question of whether IC information is "transparent, robust, reliable, and verifiable" (Petty and Guthrie, 2000, p. 161) rises again. In doing so, auditing the quality of data helps to understand the usefulness of Big Data for decision-making and, consequently, the implications for the value of IC.

To assure the quality of data on which IC depends, auditors will need to assure both hard and soft organisational resources. Gay and Simnett (2015, p. 432) suggest that auditors should not have difficulty in assuring intangibles, such as IC, as they are similar to scrutinising "for property plant and equipment" for which international audit standards (IAS) already exist. While current IASs may help assure the valuation of hard technology on which the IC in the organisation relies, it may prove problematic when attempting to assure the soft organisational resources. Krahel and Titera (2015) also stress the auditor should rethink their scrutineering role in a Big Data environment and focus much more on interpreting and judging analytics, and this in itself will require a change to the audit standards. It is this latter area of know-how, skills and expertise (human capital) to judge IC that auditors are facing significant challenges in.

Auditors are used to dealing with data that is structured and can be compared to benchmarks (Brown-Liburd *et al.*, 2015) but, in Big Data systems IC, is derived from multiple sources and often in unstructured ways. If auditors wish to continue expressing opinions about data quality, auditors will have to be trained in data ambiguity rather than oversimplifying the solution to overcome the vagueness of the situation (Lowe and Reckers, 1997). Until now, auditors have only been required to consider the implications of monetary transactions. Now, the auditors' accountability is being extended to a domain where they are required to provide assurance over data that are not only measured in non-financial terms but also obtained from less structured environments.

3.2 Data security and privacy: The fault of Big Data's competitive edge

The fact that the Big Data phenomenon has amplified the security and privacy risks is neither new, nor is it surprising. In their article, La Torre *et al.* (2018) conclude that "voracity for data represents a further ‘V’ of the Big Data paradigm, which results in a continuous hunt for data beyond legal and ethical boundaries”. Cybercrimes, data security breaches and privacy violations characterise the Big Data ecosystem and threaten organisations’ IC and value creation (La Torre *et al.*, 2018).

Privacy-related risk is an old issue that has gained great resonance over the last decade due to the regulation of privacy and data protection (e.g., the recent European General Data Protection Regulation[i] 2016). Despite the proliferation of privacy laws, Roth (2010) shows that current privacy legislation will be severely challenged to contend with breaches of privacy resulting from online activities. Toy and Hay (2015) indicate that the reason why privacy laws were facing challenges was due to the vast amount of business information processed overseas, which fell outside a particular country’s jurisdiction. Rubinstein (2013, p. 4) proposes the idea that Big Data contests the bedrock of “privacy laws by enabling re-identification of data subjects using non-personal data, which weakens anonymization as an effective strategy” to protection. If organisations want to create IC based on Big Data, not knowing which legislation is applicable will be problematic for companies.

In performing data mining, there is a high probability of accessing and using people’s personal or sensitive data. This poses questions about the ethical boundaries of using Big Data, because collecting public and legally accessible data does not necessarily mean it is ethically correct or socially legitimated (Boyd and Crawford, 2012). However, violating people’s privacy is not the only risk coming from Big Data usage and its environment.

A data breach or a cybersecurity event can have several effects on organisations and their IC. For instance, losing the confidentiality, integrity or accuracy of personal and organisational data because of a data breach can be detrimental for an organisation’s reputation, customer’s trust or even its intellectual property (La Torre *et al.*, 2018). Furthermore, sabotaged data can negatively affect data quality and reliability, and the overall theft of organisational knowledge can threaten an organisation’s competitive edge (La Torre *et al.*, 2018). Therefore, privacy violations and cybersecurity risks undermine the basic assumptions underpinning Big Data’s capability to provide a competitive edge.

According to the arguments above, we advocate that the competitive value lying in Big Data can be questioned because of the rationales below:

- In the current digital economy, data can keep its intrinsic value until a perception of the risk that people’s privacy is undermined becomes real and widespread. This is demonstrated by the recent case of Cambridge Analytica and the consequent loss of $35 billion in Facebook’s market value[ii].
- Maintaining and protecting the confidentiality of data (both organisational and customer data) is a basic requirement to gain its potential to produce a competitive edge, because when the knowledge within particular data becomes commonly accessible, then that knowledge will be likely replicable by competitors.

This second point unveils and introduces the fallacy of composition behind the taken-for-granted assumption of Big Data's value. Let us take the example of a football match: if one person stands up from their seat, they can see the match better but, if everyone stands up, no one can see well. Similarly, if the Big Data revolution relies on the organisations' ability to use and analyse public data from external sources (e.g., social media and the web), which fosters a more transparent society (McKinsey Global Institute, 2011), then where is its distinctive value for a single organisation? Accordingly, who has the privilege of using confidential and secret data that can provide a competitive edge and value for IC (La Torre *et al.*, 2018)? In this context, our interest is to investigate how IC accounting can help to understand and enhance awareness about the implications of privacy and security breaches in using Big Data.

3.2.1 IC measurement for privacy and security risks

Measuring IC should aim to support organisations in managing IC and its resources (Roos and Roos, 1997). In the case of Big Data, measuring IC should focus on the causes of the loss of its value, such as the events affecting the privacy and confidentiality of data. Within IC management, data protection practices can preserve a condition of security (confidentiality, integrity and availability) and ensure that the security risks are properly managed. An information security management system aims to preserve "the confidentiality, integrity and availability of information by applying a risk management process and gives confidence to interested parties that risks are adequately managed" (ISO, 2013, p. V). Even though this task belongs to the larger domain of risk management, it involves the entire organisation, as it should be "part of, and integrated with, the organization's processes and overall management structure" (ISO, 2013, p. V). Therefore, information (or even cyber) security management engages the entire organisation through both technological solutions and organisational processes.

Of course, a security management system uses technology intensive tools to identify, detect and respond to cybersecurity events, so puts in place solutions for protecting and recovering networks (NIST, 2014, pp. 8, 9). However, cyber security management goes beyond the mere technical issues. La Torre *et al.* (2018) argue that to get value from Big Data, companies need to reshape and transform their IC, setting up its structural and human capital. This is because new procedures, processes and culture need changing; along with instilling new skills, capabilities and human behaviours. This transformation extends to a wider governance structure and dynamics to protect data and IC from the risks of cyber-threats and data breaches.

Sen and Borle (2015, p. 314) find that greater investments in IT security can correspond to a higher risk of data breach incidents and "a possible explanation for the contradiction is that investments in IT security are not being spent on the right kind of data security controls". Therefore, in revising their human and structural capitals, companies need to establish procedures, processes, knowledge and skills to build proper practices for data security (La Torre *et al.*, 2018).

Alharthi *et al.* (2017) point out that "although technology glitches may lead to privacy or security breaches, it is the behavioural side of privacy and security that is often most problematic" because, “as long as humans are in charge of the data”, even advanced technical security measures can be unsuccessful (p. 291). Human resources and organisational culture are the main factors for an effective security management system and are usually considered the weakest components (Chang and Lin, 2007). Thus, IC measurement and management need to revise their practices and models in a way that provides understanding and awareness of how human capital and organisational processes (structural capital) support data security practices. By this, IC measurement in action can fruitfully contribute to explaining the extent that IC management is ready to face and control the risk of privacy and security breaches.

3.2.2 Data breaches and IC reporting and disclosure

While IC measurement can directly support internal decision-making and managerial actions for data security programs, the information about privacy and security issues are also important for external stakeholders. When customers’ data is breached because of a security incident, they have the legitimated interest of being informed about the risk for their privacy. Accordingly, over time, many countries around the world have regulated the people’s interest by requiring organisations to notify their customers when there is a reasonable risk that their personal data has been lost or stolen, and this process of regulating and modernising data breach disclosure laws is still in progress. For example, Australia introduced a new data breach notification law, effective from February 2018, to force companies to disclose information about any data breaches[iii]. Therefore, disclosing information about security incidents and privacy violations has become an important piece of corporate disclosure.

By adopting data breach disclosure laws, many countries intend to protect the privacy of customers and their personal data. For example, a study by Romanosky *et al.* (2011, p. 256) demonstrates “the adoption of data breach disclosure laws reduces identity theft caused by data breaches, on average, by 6.1 percent”. However, there are further economic and societal reasons that motivate the public interest for data breach disclosures. As demonstrated by Veltsos (2012) a data breach notification, as required by the law, assumes the shape of bad news, which companies should not be afraid to refer to in their communication. A data breach can have several effects and costs for organisations – both direct and indirect (Ponemon Institute, 2016). However, at an empirical level, little is still known about the effects of data breaches on businesses.

Gatzlaff and McCullough (2010, p. 77) find that the “the stock market responds negatively to announcements of breaches of customer and/or employee data at publicly traded firms”, so demonstrating an overall negative effect of a data breach on shareholder wealth. Such a negative market reaction is stronger when firms have higher growth opportunities and market-to-book ratio and refuse to provide details about the breach (Gatzlaff and McCullough, 2010). Accordingly, because of the effects of data breaches and security events for businesses and their stakeholders (other than shareholders), there is an important rationale for supporting the inclusion of new information and topics into corporate disclosure practices. However, disclosing or reporting information on data breaches is not enough to provide shareholders and other stakeholders with a complete picture of the security risks companies can incur.

Data breach disclosure only addresses the external information needs about the security and privacy violations after the security event happens. External stakeholders may require further information to evaluate how corporate and personal data are managed and protected, and whether the risks of privacy violations and the risks of data breaches are properly managed. In this context, IC reporting can contribute by providing information externally on the privacy and security programs for protecting data before a security incident may occur. This means producing information about how human capital (e.g., employees' skills, expertise and training programs) and structural capital (e.g., technologies, procedures and information systems) help protect data and its confidentiality.

3.2.3 IC auditing for data protection

Under the International Standards of Audit 250 (IFAC, 2017) auditors must consider the laws or regulations that have a material direct or indirect effect on the financial statements. If the statements are based on Big Data and if the privacy laws guiding the premise of Big Data is unknown, how will the auditors be able to express an opinion on the IC (product) created from Big Data?

Messier *et al.* (2017) indicate that auditors require evidence that managers have considered the adequacy of IT general controls designed to address financial reporting or information that can affect financial reporting risks. These risks include cybersecurity and privacy risks brought about by Big Data ecosystems. If managers admit that they do not understand these risks, how can auditors rely on the assurances management provides? Furthermore, if the protection and control of a company's Big Data, which they use to create IC, is vested only in the hands of IT executives, it transgresses the most fundamental characteristic of satisfactory internal control, namely segregation of duties (Gay and Simnett, 2015). In the audit process, auditors, who are supposed to "lend credibility to information disclosed" (Rezaee, 2002, p. 278), place significant reliance on evaluating the clients' internal control systems. Auditors use to audit against principles will be well placed to provide the trust required. Traditionally when users required assurance of company information, they looked at the auditors to provide this trust. Thus, due to the forces coming from Big Data use and the need for data protection, there are substantial changes to the aim and responsibility of auditors, who are currently predominantly concerned with the accuracy and reliability of the data in respect to shareholders. The auditors' accountability is extending its domain to protecting data with the aim of giving confidence to internal and external interested parties informed about data security and related risks.

This renewed auditing task emerges from a context where the paradigm 'data-as-value' and new sources of monetary value posit new challenges to the auditing activities. The changes in value recognition will be particularly relevant when auditors have to attest to the monetary value created from data. For example, Facebook recently reported that it is planning to "put less news in its news feeds" (Fischer, Halpern, Mattu and Wolk, 2018) which significantly impacts the billions of dollars spent by news publishers on Facebook's previous business model – a business model the publishers deemed was creating IC. If continuous auditing and/or auditing by exceptions is to succeed, data security must be addressed. “The system will need to be protected against physical and logical access. Logical access is the ability to read or manipulate data through remote access” (Zhao *et al.*, 2004, p. 395). Auditors can only attest to data security if they are sure that the data security standards are communicated and data security procedures, policies and standards are in place and monitored.

Appelbaum *et al.* (2017b) point out that the client confidentiality rules currently in place do not allow for sharing data among clients. Many social, institutional and regulatory pressures are forcing organisations to adopt effective data protection and security systems. Because of the societal concerns and legal requirements around the world about data privacy, companies need to establish procedures, processes, knowledge and skills to build proper data protection practices (La Torre *et al.*, 2018). Thus, managerial activities and IC management for using Big Data need to change.

The renewed focus on auditors relates to an IC ecosystem where the paradigm data-as-value and new sources of monetary value coming from data posit new challenges to audit assessment. Thus, the auditors’ accountability within the data protection practice is extending to protecting data to give confidence to interested parties about the effects of data security and related risks on business. The changing technological conditions under which auditors operate means that the traditional auditors’ task of “hearing” (‘*audire*’ from Latin) (Rasinski *et al.*, 2011) needs to be extended to new grounds that creates risks for IC and business overall.

3.3 Visualisation and users interaction: where data is not enough

Because of the increasing amounts of data to analyse, good visualisation tools are crucial for Big Data (Assunção *et al.*, 2015), as the presentation of analytics facilitates user interaction with knowledge and confers quality to data. Big Data’s value lies in its ability to improve decision-making, and its value for IC depends on the capability to transform data into useful business purposes. Within the chain to transform data into information and knowledge, there is an intensive involvement of human tasks (Tien, 2013; La Torre *et al.*, 2018). Therefore, data quality also depends on the extent to which data analytics are designed for human interface.

Data visualisation includes “various techniques for creating images, diagrams, or animations to communicate, understand, and improve the results of Big Data analyses” (Secundo *et al.*, 2017, p. 254); but it also involves the early activities of managing and processing raw data (Assunção *et al.*, 2015) because of the larger size of datasets compared to traditional ones (Philip Chen and Zhang, 2014). Thus, data visualisation represents a challenge in the field of Big Data (Assunção *et al.*, 2015) that reflects both technical and non-technical issues in the users’ interaction with data.

Enhancing user interaction implies aligning the visual interface of data and analytics to the users’ cognition schemes, or vice-versa. This means adopting highly customisable visual interfaces in the first case, or, contrarily, adapting human understanding to common visualisation practice, which is, however, slower to achieve. Birnbaum *et al.* (2017, p. 1) state, “spreadsheets and graphs are useful representations of data, but only to the people who understand such graphs and spreadsheets". Baumgarten *et al.* (2013) claim that to realise Big Data's benefits, organisations must align their internal structures, procedures and skills with Big Data's technological advances. Similarly, Wang *et al.* (2016) assert that Big Data analytics cannot replace the role of human-expertise in decision making and management models. Thus, data visualisation and human interaction pose an important challenge to getting value from Big Data in developing and using knowledge and improving decision-making.

Interestingly, Hammond (2013) clarifies that Big Data's value is not the data but it lies in the ability to connect data and evidence into a story that narrates facts. He argues:

> *There is a huge distinction to be made between "evidence" and "data." The former is the end game for understanding where your business has been and where it needs to go. The latter is the instrument that lets us get to that end game. Data itself isn't the solution. It's just part of the path to that solution. (Hammond, 2013, p. n.a.)*

Thus, data visualisation should be able to turn data into a story for decision makers.

Hammond (2013) points out that to capitalise on Big Data, there is a need to gather human insights at a machine scale. Performing data analysis is not enough because systems need to "communicate the results that they find in a clear, concise narrative form" (Hammond, 2013). Therefore, data analysis and data visualisation are only a part of the whole process of transforming data into knowledge. The rest of the process is about connecting data and results with business facts and translating them into a narrative story. The second part of the process can facilitate human interaction with data analytics and make sense of the data. In such a context, IC measurement and reporting in practice and research can provide useful insights for narrating and visualising knowledge.

3.3.1 IC measurement: the narrative turn of data

The main message of Hammond (2013)'s article is that Big Data's value is not the data but the narrative because "stories from the data can bridge the gap between numbers and knowing". As he underlines, narratives generated through machine or human intelligence provide "the human link between the world of big data and the actual end game we want: a world of evidence-based insight and decision-making" (Hammond, 2013). Here, once again, numbers and data are not the end game but open up an old and controversial debate into IC accounting research about the usefulness of combining numbers and narrative (Dumay and Rooney, 2016).

In measuring IC, the dominant belief states the need for quantitative rather than qualitative information, but this belief has often been questioned because, as Dumay and Rooney (2016) state, balancing numbers and narratives in IC accounting depends on actors' competing inscription processes. Dumay (2009, p. 205) states that most of the mainstream IC measurement frameworks fall into the "accountingisation" trap, as an approach of "reifying IC in the same manner in which tangible assets are portrayed within accounting, which is akin to attempting to make the intangible

tangible". This highlights the IC concept instead of IC practices and thus contributes very little to developing a practical understanding of IC in action (Dumay, 2009, p. 205). Therefore, although IC measurement represents the 'seed' for making sense of IC, it tends to lock-in IC's potential in accounting (Chiucchi and Dumay, 2015) and makes IC "accountingisation" a barrier for IC and Big Data management.

Here again, IC narratives can demonstrate their power over numbers in the context of Big Data. Numbers are open to different interpretations, and the meanings information users get from numbers are usually reflections of their own personal views and contexts (Dumay, 2015). Instead, as Llewellyn (1999) points out, the narrative gives a sense of the world and people's lives because:

> *In everyday life narration is privileged over calculation. We understand our lives through narratives, narrating experiences first to ourselves - to convince others - and then to others - to persuade them*
>
> *(Llewellyn, 1999, p. 220).*

Thus, we advocate that, if measuring IC aims to support managing IC and knowledge from Big Data, then calculation is not enough for enhancing data visualisation and improving users' understanding of data analytics. To unlock Big Data's value, measuring knowledge from data analytics requires an approach that privileges narratives over numbers.

3.3.2 IC reporting: visual elements and inscription

Data visualisation directly impacts how data, information and knowledge are reported to users, both internally and externally. The purpose of reporting Big Data analytics is to facilitate a collective understanding and users' interaction with data through numbers, narrative and visual elements. In this case, IC reporting can contribute to enhancing such an interaction. In their study, Mouritsen *et al.* (2001, p. 735) demonstrate that the IC statement (or IC report) becomes "a centre of translation, which mobilises knowledge management via three interrelated elements: knowledge narratives, visualisations and numbers". By this, "writing intellectual capital is a local story, which often concerns making knowledge collective and a process of allowing it to be oriented towards organisational ends" (Mouritsen *et al.*, 2001, p. 735). Therefore, the benefit of producing IC reports and writing an IC story is to transform individual and tacit knowledge into collective knowledge and understanding.

Similarly, in the Big Data context, reporting IC information for internal purposes or external divulgation needs a further effort that goes over reporting quantitative data and indicators. In their research, LaValle *et al.* (2011, p. 25) unveil that the most common impediment for companies to become more data-driven is the "lack of understanding of how to use analytics to improve the business". Accordingly, they find that visualising data differently is the most valuable ability and source of value for organisations, because simulations, dashboards and illustrations can make data analytics readily understood for business purposes and transform them into actions (LaValle *et al.*, 2011). Therefore, Big Data analytics about IC resources need connections to a story and to have context within the broad business value creation story through numbers, narrative and visual elements. This does not mean that spreadsheets and charts are losing their importance (LaValle *et al.*, 2011), but it signals the need to complete the IC information picture to overcome the abstractness of numbers (Dumay, 2015) and produce inscriptions from Big Data analytics.

4 Research implications and conclusion

In this paper, we reflect on the future of IC accounting in the era of Big Data. Big Data is gaining momentum in accounting research and practice, but its potential is not limited to supporting traditional accounting techniques and practices. Big Data applications and technologies represent a new important asset for IC as they directly benefit an organisation's IC to generate and manage knowledge (Secundo *et al.*, 2017). Accordingly, IC accounting can contribute to understanding and controlling the determinants of Big Data's value, such as data quality, privacy issues, data visualisation and user interactions. Therefore, in responding to the main question motivating this paper, our answer is that Big Data is likely an important driver for a renewed interest in IC accounting in the current digital ecosystem.

Big Data's value lies in an organisation's IC capability to use and protect the potential value of data. In the process of transforming data into information and knowledge for management, data quality, security and privacy breaches and data visualisation represent both the drivers and main barriers for exploiting Big Data's value. In managing these drivers, measuring, reporting and auditing IC can help organisations and their external stakeholders understand and use Big Data and address the digital risks affecting IC value (e.g., privacy and security incidents). In doing so, IC accounting needs to focus on how human capital and organisational processes (structural capital) can unlock or even obstruct Big Data's value for IC.

In practice, this means that measuring and reporting the organisational capability and people's skills in managing and using data can increase trust in data quality and reduce uncertainty about the reliability of Big Data analytics (Hazen *et al.*, 2014). Additionally, IC measurement and auditing can fruitfully contribute to explaining, facing and controlling privacy and security breach risks. This implies not only introducing new forms of voluntary disclosure when a data breach occurs but also producing information about how human capital (e.g., employees' skills, expertise, training programs) and structural capital (e.g., technologies, procedures, and information systems) are employed to protect data and its confidentiality.

Finally, when the barrier of data visualisation is removed, it becomes clear that Big Data's value does not lie in the data itself, but in the ability to transform data into a story that connects data with facts. Data analysis and data visualisation are only a part of the whole process of transforming data into knowledge. To facilitate human interaction with data analytics, and to make sense of data, we need to connect data and analytics with business facts and translate them into a narrative. Thus, narrating and visualising knowledge become an important facet of drawing value from Big Data.

4.1 Projections for future research

This article contributes to enriching awareness about the practical factors underpinning Big Data's value for IC and fosters the cognitive and behavioural dynamic between data, IC information and user interactions. Within the infancy stage of linking Big Data into IC and accounting research, this article supplies insights for undertaking new avenues of IC accounting research in the context of Big Data. Thus, we call for future empirical studies to explore IC accounting practices for, and in the context of, Big Data by addressing the research questions below:

- How can measuring and reporting on organisational human capital and internal capabilities influence the perception of, and trust in, Big Data?
- Are auditing practices able to assess and assure the quality of Big Data and its value for IC?
- How do security risks and privacy issues influence IC?
- How can new practices for measuring, reporting and disclosing IC enhance stakeholders' awareness of the security and privacy risks?
- Do new auditing practices enhance or weaken data protection and privacy?
- How can narrative and visual elements facilitate human interaction with Big Data analytics and knowledge?
- How can the narration of Big Data analytics influence actors' inscription within an organisation?
- Finally, does Big Data's value for IC lie in the data itself?

4.2 Concluding remarks

To conclude, we advocate that practitioners and researchers need to face the challenge of avoiding the IC accountingisation trap to make IC accounting relevant for Big Data within this renewed interest in IC accounting. IC cannot be treated like tangible accounting assets (Dumay, 2009; Chiucchi and Dumay, 2015). Similar to what has already transpired in the knowledge economy, attempts to evaluate Big Data's financial value by making the intangible tangible, and the temptation to quantify the value of data in monetary terms, may be counterproductive. However, as we previously argued, if measuring IC supports managing IC and knowledge from Big Data, then calculation is not enough for enhancing users' understanding of Big Data analytics. To unlock Big Data's value, measuring the knowledge derived from data analytics requires an approach that privileges narrative over numbers. Therefore, Big Data analytics for IC resources needs to be connected to the context of the broader business value creation story through numbers, narratives and visual elements.

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