

Big Data, Big Decisions: The Impact of Big Data on Board Level Decision-Making

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Abstract

Big Data (BD) has the potential to ‘disrupt’ the senior management of organisations, prompting directors to make decisions more rapidly and to shape their capabilities to address environmental changes. This paper explores whether, how and to what extent BD has disrupted the process of board level decision-making. Drawing upon both the knowledge-based view, and cognitive and dynamic capabilities, we undertook in-depth interviews with directors involved in high-level strategic decision-making. Our data reveal important findings in three areas. First, we find evidence of a shortfall in cognitive capabilities in relation to BD, and issues with cognitive biases and cognitive overload. Second, we reveal the challenges to board cohesion presented by BD. Finally, we show how BD impacts on responsibility/control within senior teams. This study points to areas for development at three levels of our analysis: individual directors, the board, and a broader view of the organisation with its external stakeholders.

Keywords: Boards, Directors, Big Data, Knowledge-Based View, Capabilities, Decision making

Highlights

- There is a shortfall in directors' capabilities for dealing with Big Data.
- Board cohesion can be disrupted by Big Data, compromising the decision-making process.
- Boards need to develop cognitive capabilities and find new ways to make decisions in the Big Data era.
- Big Data provides firms with opportunities to enhance their adaptive capabilities.
- Boards need to work in new ways to meet the challenges that Big Data can present.

1. Introduction

The potential of new technologies to ‘disrupt’ the management of organisations, including at the most senior levels, has recently been noted by many scholars (e.g. Evans, 2017; Abbasi, Sarker & Chiang, 2016; Valentine & Stewart, 2013). One striking example of this disruptive effect is the challenging role played by ‘Big Data’ (BD) for directors and decision-makers (Janssen, van der Voort & Wahyudi, 2017). The sudden rise of BD as a new knowledge source has prompted corporate decision-makers to make decisions more rapidly and to shape their capabilities to proactively address environmental changes (Fosso Wamba, Akter, Edwards, Chopin & Gnanzou, 2015).

Despite considerable research on making strategic (important, novel and resource hungry) decisions and the characteristics of these processes (Hickson, Butler, Cray, Mallory & Wilson, 1986; Whittington, Cailluet & Yakis-Douglas, 2011), there is little research on how BD has influenced the way decisions are made, on the impact of data proliferation on strategic responsibilities (Chari, Katsikeas, Balabanis & Robson, 2012; Quinn, Dibb, Simkin, Canhoto & Analogbei, 2016), or on how these data are handled at board level (Nutt & Wilson, 2010). A previous empirical study (Hickson, Miller & Wilson, 2003) has identified the ‘knowledge base’ used by UK senior managers to inform their strategic decision-making as the single most important factor in the decision’s success. However, while this was a large study with 55 UK cases, it mainly spanned a period where information for decisions was largely well-known (extant knowledge), available in hard copy as reports (explicit knowledge), or resided in managers’ heads based on their experience or judgement (implicit or tacit knowledge).

The explosion of knowledge which has accompanied increasing access to BD arguably has a large impact on both how and what information senior managers use to

inform their decision-making. A key research question is whether or not BD has changed the process of board level decision-making and, if so, how and to what extent? Our research addresses this question at three levels: first, we consider the implications of BD for *individual directors*; second, we explore BD's influence on the way that *the board* works; third, we review the impact of BD for *the wider organisation and its external stakeholders*. Knowledge Based View (KBV) is selected as a suitable theoretical framework because it helps us to understand why a “[l]ack of knowledge about BD sources influences decision-making quality” (Janssen et al., 2017, p. 339). For example, previous research (e.g. Raghunathan, 1999) confirms that the decision-making quality improves when directors have greater knowledge of the relationships among problem variables.

2. Theoretical approach

We situate our research approach to draw from KBV. In doing so, we explore the implications of BD for strategic decision-making undertaken by the board. For the purposes of our approach, we follow McAfee and Brynjolfsson (2012) by regarding BD datasets as being characterised by high levels of volume, velocity and variety. As such, BD is defined by dataset size (Erevelles, Fukawa & Swayne 2016; George, Osinga, Lavie & Scott, 2016) and the challenges these data place on computing capacity (Fosso Wamba, Gunasekaran, Akter, Ren, Dubey & Childe, 2017).

In viewing strategic decision-making as a process of making choices under varying conditions of uncertainty (Milliken, 1987; Petrakis, Kostis & Kafka 2016), the decision-making literature cites a lack of information as a key source of uncertainty (Nutt & Wilson, 2010). In the BD era, a lack of information is transformed into an abundance, with the potential to reshape data into usable information (Tihanyi, Graffin & George, 2014). As such, these data offer the potential to reduce decision-making risk and

improve strategic decision-making by allowing senior leadership teams to take a more holistic view (Filatotchev & Nakajima, 2010).

However, while there is little doubt that the BD explosion is being felt in wider society, in business relationships, and in crafting public policy; much less is known about its impact on the behaviours of senior managers taking decisions that matter. Since strategic decisions are typically defined as those that are without precedent in the organisation, they are costly in terms of financial and human resources; they are also inherently complex (Hickson et al., 1986; Hendry, 2000). There is rarely one best solution, rather a series of possible solutions, and each solution is a result of trade-offs and priorities in balancing risk and control (McNulty & Pettigrew, 1999). Although McAfee and Brynjolfsson (2012) suggest that profitability and productivity benefits ensue when BD is applied, these authors do not investigate the processes by which this occurs, nor how senior managers make data part of their decision-making routines. This gap highlights a key area for investigation.

The advent of BD has also spurred changes to board processes and structures with potential consequences for how strategic decisions are made. Chief Data Officers, Chief Information Officers or Chief Analytics Officer (Côte-Real, Oliveira & Ruivo, 2016; Fosso Wamba et al., 2015) are defined as a new breed of executive that some leading organisations are seeking to hire to improve their usage of BD in decision-making (Lee Madnick, Wang, Wang & Zhang, 2014). There is also evidence of boards moving away from top-down planning; instead processing large amounts of digital data, adopting techniques such as competency modelling (drawing on the resource-based view of the firm) and real-options analysis (drawing on financial strategy) (Camillus, 2008). The complexity of the decisions being made and of the data being used, which may induce feelings of certainty or bewilderment and prompt decision-makers to take highly risky

decisions, is worthy of attention. As Camillus (2008, p. 17) notes, boards have problems because they ‘can’t develop models of the increasingly complex environment in which they operate’. This juxtaposition of ‘big problems’ and ‘BD’ provides a further area for investigation.

We adopt a knowledge-based view (KBV) to situate the research and guide the analysis (Nonaka, 1994; Spender & Grant, 1996; Felin & Hesterly, 2007). KBV scholars take an extensive view of data as a key resource in decision-making – a view theoretically articulated and empirically revealed in research taking a resource-based view of the firm (Wernerfelt, 1984; Priem & Butler, 2001; Barney, 2001). We argue that data can be viewed as a key resource which may be mobilised around decisions or incorporated into organisational intelligence as a more latent routine (with the potential for use in later decisions). For example, Collinson and Wilson (2006) empirically demonstrated the creation of latent routines via knowledge acquisition as a key feature of successful Japanese organisations.

The KBV is not, however, unproblematic. As Spender and Grant (1996, p. 48) observed, we need ‘a clear statement of the epistemology which gives it (knowledge) meaning’. We also take the view that a single theory of knowledge is possibly untenable because of the many different types and definitions of knowledge. However, approaching the question of *how* knowledge is utilised (as in this paper) and not solely an examination of *what* knowledge is, avoids definitional plurality debates around knowledge (Spender & Grant, 1996). Nonaka and Takeuchi (1995) capture the plurality of knowledge as either explicit or tacit on the one hand, or on the other, how it is situated at various levels of analysis (from the individual, to group to organisational and inter-organisational levels).

To unpack the plurality of the KBV, this paper explores the key determinants of knowledge at three different levels: the director/individual level (managerial cognitive capabilities); the board level (behavioural factors); and the stakeholders' level (dynamic capabilities). These three perspectives – cognitive capabilities, a behavioural view and dynamic capabilities – all sit comfortably within a KBV-based approach, because they seek to explain the antecedents and consequences of knowledge. Capabilities refer to the ability to use knowledge (Amit & Schoemaker, 1993; Ambrosini & Bowman, 2009) that – as a key resource – affects the ways in which the board behaves. In particular, the extant literature accepts that in today's turbulent environment, companies need to continuously improve and re-shape their knowledge to respond promptly to external pressures (Lin & Wu 2014; Wu, 2010). Knowledge as a unique and distinctive resource provides the 'basic foundations to renew or re-configure its resource base' (Côte-Real et al., 2016, p. 380) and to build capabilities.

Managerial cognitive capabilities (at individual/director level), behavioural factors (at the board level) and dynamic capabilities (at the stakeholders' level) are interdependent concepts of the KBV framework. Grant (1996) considers organisations as entities where specialised knowledge of individuals (directors) is integrated to form organisational-level or group-level knowledge that can in turn lead to sustainable competitive advantage. Previous research (Helfat & Peteraf, 2015) documents that managerial cognitive capabilities, behavioural factors and dynamic capabilities affect the quality of decisions, as these capabilities facilitate the early recognition of environmental threats or opportunities that can impact on the quality of the decision-making process. Therefore, in the context of BD, a focus on managerial cognitive capabilities (at individual/director level), behavioural factors (at the board level) and dynamic capabilities (at the stakeholder level) allows the researcher to explore whether

and how BD are part of the set of capabilities and knowledge that companies and decision-makers need to develop.

At the *individual level*, directors and managers need to develop the mental models and skills, or managerial cognitive capabilities (Helfat & Peteraf, 2015), to perceive, analyse and process changes in the environment. This cognitive process has been defined as ‘cognitive complexity’ (Schneier, 1979), and the literature notes it may lead to cognitive biases (Amit & Schoemaker, 1993), such as anchoring (i.e. old way of thinking), cognitive dissonance (i.e. holding conflicting beliefs or ideas) (Brennan & Conroy, 2013). The lack of cognitive capabilities can also cause boardroom or organisational inertia (Tripsas & Gavetti, 2000). The cognitive view (Chaston & Sadler-Smith, 2012) offers important insights into why directors may act conservatively, clinging on to more traditional processes which have been institutionalised since the pre-digital era. In particular, cognitive capabilities are especially enhanced in an uncertain and complex environment characterised by rapid changes (Carpenter & Fredrickson, 2001).

At the *board level*, a key concept in understanding boardroom behaviour concerns the notion of routines (Grant, 1996). Routines consist mainly of knowledge that is tacit and hard to codify (van Ees, Gabrielsson & Huse, 2009); they refer to behaviour that is learned, repeated and rooted in tacit knowledge (Winter, 2003). Additionally, we note that routines at the boardroom level are related to cognitive capabilities (at the individual/director level). Routines ‘conserve the cognitive abilities of board members and [...] they direct attention to selected aspects of identified problem situations; [...] they also create decision-making biases’ (van Ees et al., 2009, p. 312). A KBV perspective is consistent with the view that boardrooms use stocks of knowledge, routines and capabilities to take actions (Balogun & Jenkins, 2003). When exploring

how boards process BD, it is essential to consider decision-making behaviour. A key factor, over and above the availability and type of data, is how the board uses it to make decisions; this may be the most influential factor of all. Behavioural Economists, such as Kahneman (2011), state that no matter how complex, refined or available data may be, decision-makers are unlikely to fully consider it, and so often make inaccurate decisions.

At the *stakeholder level*, companies are expected to proactively respond to environmental changes by correctly anticipating the stakeholders' needs (Wang Senaratne & Rafiq, 2015). Dynamic capabilities encompass the ability to secure new and additional knowledge, by empowering decision-makers to proactively address environmental changes (Oliver, 2016; Reeves & Deimler, 2011). The firm's ability to update and reconfigure its competencies (dynamic capabilities) includes reshaping and reinventing existing and novel knowledge to respond to external changes (Teece, 1998; Ambrosini, Bowman & Collier, 2009; Barrales-Molina, Bustinza & Gutierrez-Gutierrez, 2013) and to seek to shape its environment (Eisenhardt & Martin, 2000). As BD provides new insights into environmental trends, its use can improve dynamic capabilities by supporting corporate decision-makers in being responsive and adaptive to current dynamic environmental demands (Erevelles et al., 2016). As a result, organisations need to 'integrate, build and reconfigure' competencies to meet the environmental changes BD highlights (Teece, Pisano & Shuen, 1997, p. 515). BD processes should also become part of firms' dynamic capabilities (Braganza, Brooks, Nepelski, Ali & Moro, 2017) and of the decision-making process (Davenport, Barth & Bean, 2012). The use of external knowledge through absorptive capacity (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998) fosters the flexibility needed to cope with dynamic environments (Ambrosini & Bowman, 2009). We claim that this acquisition

and use of external knowledge requires the organisation to develop its absorptive capacity, based on its previous knowledge, the cognitive capabilities of its directors and the behavioural pattern adopted in the boardroom.

This paper addresses the research gap identified by McAfee and Brynjolfsson (2012) and George et al. (2016), for scholars to empirically examine the impact of BD on decision-makers. Drawing on the KBV, three analytical lenses are used to investigate how boards take strategic decisions in the light of BD. First, we view BD as a knowledge asset for the board; secondly, we propose that this asset, although necessary, is not sufficient and may vary in its value depending upon cognitive and dynamic capabilities; and thirdly, we introduce behavioural factors to the study of decision-making activities.

3. Methodology

This research applies a blend of inductive and deductive processes (Graebner, Martin & Roundy, 2012) to critically evaluate the views of board directors about BD's impact on strategic decision-making. We conducted semi-structured interviews without specific constructs in mind; following Rötzeimer-Keuper, Hendricks, Wunderlich & Schitzmz's (2018) approach, data was analysed using standard thematic qualitative coding techniques. However, during the data analysis, definitions and themes were drawn from the existing literature (e.g. Graebner, 2009). During the analysis process, the impact of BD on strategic decision-making emerged from the data. Therefore, the inductive approach mentioned above refers to our process of data analysis, rather than the overall research design per se. Our results are emergent from the data, but later compared with the extant literature to make sense of the findings. Data sources included key-informant interviews and secondary-sourced materials and artefacts. Key-informant interviews with 20 directors followed a semi-structured checklist of issues

derived from the research questions (see Appendix A). This format allowed a free-flowing conversation, in which the pre-determined issues of importance could be explored in depth, supported by follow-up questioning. The interviews focused on the impact of BD on board level decision-making. Among the topics covered were the informants' previous and current roles; organisation profile; role of the board and its members; governance and strategy processes; use of data in decision-making; complexity and uncertainty in the decision-making environment; role of stakeholders; and the potential benefits and challenges associated with BD. Most interviews were conducted by at least two research team members, increasing the opportunity to ask questions and gain insights from witnessing the data gathering first hand. All interviews were audio recorded and transcribed. Contemporaneous field notes were taken and checked following each interview. The interview length ranged from 90 to 150 minutes, yielding a data set of over forty hours of material.

Secondary data analysis increasingly is used in corporate governance (Ravasi & Zattoni, 2006; Bailey & Peck, 2013) and management studies (He & Baruch, 2010; Hajro, Gibson & Pudelko, 2017). Among the secondary data gathered were annual reports, corporate governance reports, social corporate sustainability reports, company websites, AGM reports, minutes and transcriptions, and press reports from 2008 to 2017. These insights supported our interpretation of the emerging themes concerning BD's role and impact on governance and board decision-making. The use of multiple sources contributes to the reliability and validity of the data and lessens the risk of common method bias (Jakobsen & Jensen, 2015).

3.1. Key-informant selection

Reflecting the managerial focus of the study and research questions, the use of convenience sampling and key-informant interviews (Mitchell, 1993; 1994) were deemed appropriate (Gill & Johnson, 2010). Access was gained to directors of UK-based global manufacturing and service organisations using a combination of personal networks and snowball sampling (Lecy, Mergel & Schmitz, 2014). All sampled board members were routinely involved in high-level strategic decision-making, enabling a rich understanding of the issues. The informants willingly participated in the study, indicating high levels of interest in the BD topic. The nature and scope of the research questions required high-level access to gain reliable information (Phillips, 1981). Achieving this level of access to senior informants for lengthy interviews is rare (Zattoni, Douglas & Judge, 2013), such that the board level of organisational access achieved is a distinctive feature of our study. Indeed, there is a general consensus in managerial studies noting the difficulty of gaining access to managerial elites (Leblanc & Schwartz, 2007; McNulty & Pettigrew, 1999; Daily, Dalton & Cannella Jr., 2003) for qualitative studies.

Among those interviewed were CEOs, Managing Directors, and Global Heads of Digital, from sectors including: financial services; management consultancy; FMCG manufacturing; air travel; information technology; and leisure (see Table 1). The identities of those involved are disguised to protect personal and commercial interests (Kirkup & Carrigan, 2000). As our approach was inductive and used a non-probability sampling method, it was not our aim to generalise across organisations or sectors. However, the breadth of coverage enabled us to evidence empirically common issues associated with Big Data's impact on how strategic decisions are made at the board level within diverse contexts.

INSERT TABLE 1 ABOUT HERE

3.2. Data analysis

The credibility of our research is supported through the rigorous application of methods appropriate to the research questions, and through the robust approach used to gather the required data. The sampling of experienced directors adds to the face validity of our primary data. Sampling from a range of organisation types and sectors also gives ‘maximum variation’ across the sample (Miles & Huberman, 1994), while maintaining focus on the main research questions. Following saturation, where no additional insights emerged from the data (Strauss, 1987), no further interviews were conducted. These features support the reliability of the findings (Miles, Huberman & Saldana, 2014).

The core categories from the analysis of our data were initially generated using an open-coding approach (Strauss & Corbin, 1998). Drawing on the principles of investigator triangulation (Denzin, 1989), four research team members were involved in the data analysis to help minimise bias, increasing confidence in the plausibility of the results. Using a preliminary set of openly coded data as a basis for subsequent coding, a second researcher then used Nvivo12 to independently analyse the data, assigning a subset of interrelated axial codes to the core category of open codes in a process which ‘broke the data apart and delineated concepts to stand for the blocks of raw data’ (Corbin & Strauss, 2008, p. 198). Throughout, the interview texts were systematically analysed to reveal a number of ‘categories, types and relationships of meaning’ (Guest, MacQueen & Namey, 2012, p. 52). During the final stages, the open and emerging axial codes were independently reviewed by other research team members (Campbell, Quincy, Osserman & Pedersen, 2013). Working together, three

researchers then reviewed the results to identify any discrepancies in what we label our core categories and sub-themes, until an acceptable level of reliability was achieved (Hodson, 1999; Hruschka Schwartz, Cobb St. John, Picone-Decaro, Jenkins & Carey, 2004).

Following Eisenhardt (1989), throughout the process we referred to the existing literature to continuously refine the inductive theoretical insights. Intercoder reliability (Krippendorff, 2004) and intercoder agreement (Campbell et al., 2013) were maximised by the fourth researcher, who independently coded the data to verify redundancies, reveal discrepancies, check coding reliability and identify any new categories or potential sub-themes. Finally, the research team systematically reviewed and agreed a set of finally selected core categories and sub-sub-themes, strengthening the reliability of the findings.

The analysis generated three core categories (*cognitive capabilities*, *board cohesion*, and *responsibility and control*) and eight sub-themes (*shortfall in cognitive capability*, *cognitive biases*, *cognitive overload*, *decision-making disruption*, *temporal issues*, *board composition issues*, *organisational impact of sub-groups* and *external stakeholders*), used to frame our findings (Table 2). The researchers identified 166 quotations for the first core category *Cognitive capabilities*; 101 quotations for the second core category *Board cohesion*; and 76 quotations for the third core category *Responsibility and control*. Table 2 shows in more detail the number of quotations for each core category and sub-theme in order to aid transparency in the presentation of our findings.

INSERT TABLE 2 ABOUT HERE

A record of notes and memos taken throughout was maintained. The analysis of the secondary data was additionally used to supplement the primary data findings, reflecting the need to ensure trustworthiness in qualitative research (Bonoma, 1985).

4. Findings

4.1. First core category: cognitive capabilities

As a knowledge-based resource, we expect BD to trigger the dynamic and adaptive capabilities that support strategic decision-making. We find that this process's effectiveness relies on the efficient integration of BD resources (the data itself) and BD capabilities (the technical ability to capture and manipulate it). Most informants recognised the role that BD could play in this process. As one director commented, *'...they've all got a realisation they have specific issues and they recognise that collecting large volumes of data will allow them to crack some of those issues, so they've all got to that first base'* (Informant 4). In practice, most informants found integrating BD resources and developing the necessary capabilities to be complex.

The secondary data reinforced this point, suggesting that organisations do not have the capabilities to store, manage and analyse BD. A lack of awareness that using BD as a capability or a tool has the potential to improve their decisions, means that some companies *'will find themselves in trouble with some stakeholders'* (Informant 6). The cognitive capabilities which underpin these dynamic capabilities (Helfat & Peteraf, 2015) emerged as a critical theme. Several directors spoke intently of the demands BD made on board members' cognitive capabilities. As this director explains, more time is needed to learn about and embrace the changes arising from BD, *'There is also learning in terms of a learning curve which organisations have to go through... I have to go through... my team has to go through'* (Informant 11).

We identified three interlinked sub-themes of cognitive capability that impact on strategic decision-making. The first sub-theme refers to a shortfall in cognitive capabilities on BD; the second to cognitive biases that are a consequence, and the third to the cognitive overload that can arise. The linkages between these sub-themes occur when a shortfall in cognitive capabilities ('the capacity of individual managers to perform mental activities', Helfat & Peteraf, 2015, p. 832) leads to cognitive bias (Brennan, 2016), a situation that is often compounded by being overwhelmed with data.

Shortfall in cognitive capability. Starting with the cognitive capability shortfall, we found the required technical capabilities, and those needed to integrate, build and reconfigure the necessary internal and external competencies to use the data, were often absent. Although the basic principle of using data to inform decision-making has not changed, '*What's available has increased, and the number of sources has increased, and that requires a more sophisticated set of skills to sort and prioritise*' (Informant 13). While informants recognised the data's potential, many felt personally ill-equipped to deal with it, as this director reflects, '*The solution really is being able to mine and get the insights out of all of that, and that again, is quite a technical activity and it requires heavy duty analytics*' (Informant 8). Their concerns extended beyond the technical in order to '*get the most out of this more complex world*' (Informant 18). Some mentioned the different world view of a new generation that has grown up with digital. One informant compared this generation's way of thinking with the non-linear way in which boards make decisions:

... pretty much all of us are very linear in the way that we think of information so we tell stories and we go from A to Z, everything we do is about having a beginning, a middle and an end ... It's how we've been educated, it's how we process information and it's how we strategically think and therefore deliver a result. Increasingly we're seeing the emergence of a generation who are non-

linear in the way that they operate ... if I'm talking to a ten-year-old, they're not necessarily interested in the story of Red Riding Hood and particularly interested in the outcome of the story, they might be interested in the world of Little Red Riding Hood, in which they would like to immerse themselves. (Informant 12)

There was a sense that in comparison to what could be possible, organisations are ‘...incredibly slow at adopting new data inputs’ and that while ‘...there's been a massive growth throughout the planet of availability, it [is] growing much faster than the ability to analyse it’ (Informant 1). Therefore, several informants recognised, ‘*the need of overcoming - and that was very much the primary focus*’ the constraint to which a shortfall of capability may lead (Informant 20).

Cognitive biases. Regarding cognitive biases, we found evidence of anchoring, in which old ways of thinking inhibited the decision-making process; and of poor understanding of BD. A corporate decision-maker admitted that, ‘*there's always this scepticism about how information and data is used [...] and I can understand there's an element of caution*’ (Informant 18). Reflecting on some of his client organisations, one IT consultant explained, ‘*We'll go and speak to the execs and we'll get their view of what's going on in their business and then we'll go back to the data and then we'll prove what's going on in their business with the data and say, did you know that out of the 400 hypotheses you had knocking around about your business, only 50 of them were true?*’ (Informant 9). He went on to explain, ‘...*you suddenly know whether you're talking to a bunch of people that truly have their finger on the pulse of what's driving their business, or whether they're in "cloud cuckoo land"*’.

Sometimes these problems emerged because of previous common practice of only sharing simple synopses of data with the board. One director used the term ‘*instructed data*’ to describe this format, explaining that, ‘*Big Data may well be being used within*

the organisation ... because of this channelling effect as you go towards the top, and simplification ... I'm not sure that the boards ever really get to grips with Big Data' (Informant 3).

Cognitive overload. We found cognitive overload occurs when individuals are exposed to more information than they are able to process (Bawden & Robinson, 2009). As one director explained, *'I don't think you've got enough hours in a day to solve these problems'* (Informant 7), because *'we still have an overload of data [...] and sometimes less data is better than more data'* (Informant 16). We found strong evidence of this overload's consequences for strategic decision-making. Informants referred to BD's *'immediacy ... and ... interactivity'* (Informant 14); and of the challenges information overload can bring, including *'perhaps having too much of it [BD] to really be able to analyse effectively'* (Informant 8). One director argued that *'the people who are doing well are the ones that can cut through all the crap and make decisions based on facts'* (Informant 13). Another reflected on the challenges and opportunities that access to so much data could bring:

So go back 20 years ... data availability was very different. So, insight and targeting in those days will depend on greater personal knowledge of markets, geographies... You used to rely on the person and their knowledge and ability. Today you've got a huge amount of data but not necessarily more insight unless you try very hard. (Informant 11)

This quote highlights a recurring point, that BD does not necessarily lead to good quality insight. Even those who commented positively about its potential to yield insights were cautious:

So the digital technology has changed or enhanced the amount of data and information that is available now. Doesn't necessarily mean the quality of

insight is improving, because those two are slightly different things ... But more data is available, therefore, the decision-making process is more based... can be based, on better quality information, more robust information, as opposed to having to guess what is going on. (Informant 11)

While informants noted a ‘*danger that even vast BD could be incomplete*’, on other occasions there was ‘*too much of it to really be able to analyse effectively*’ (Informant 8). Whatever the cause, overcoming this overload was seen as crucial to leveraging the insight needed to support strategic decision-making.

4.2. Second core category: board cohesion

We found strong evidence of BD disrupting the cohesive dynamics of board-level decision-making, with implications for the required dynamic and adaptive capabilities. At the heart of this disruption was the view that fundamental shifts in the board’s ways of working are required. A perceived clash between old and new ways of working, leading to tension, is evident. Insights gained from secondary data supported this finding: some companies admit to having obsolete internal information technology systems that do not perform as expected, resulting in business disruption, processing inefficiencies and loss of stakeholders. These sources tended not to indicate remedial action to plan to address these information technology systems’ issues. In our primary data we found two particular sets of temporal issues associated with *decision-making disruption*. The first concerns a clash in pace between the high velocity of BD and the typically lower speed of strategic decision-making. The second reflects a mismatch between forward-looking strategic decision-making and BD, that focuses on the past and the present. A further set of issues arises in relation to the board’s make-up and its suitability for operating in this disrupted environment.

Decision-making disruption. We found strong evidence of BD disrupting the strategic decision-making process, leading to anxiety about the impact for the organisation and worries from individuals about their personal preparedness:

We frequently come across situations where there are big variances in data; because measuring stuff is complicated; it's really tough sometimes. Even in the simplest scenario often things go a little bit wrong and you could be making poor decisions.
(Informant 17)

A different director also spoke about the '*human side of this problem*' (Informant 7), explaining a situation in which there was, '*No integration of technology, no integration of databases, but lots of very rich middle-aged men [on the board], clinging onto their very important jobs for dear life*'. While another commented that this was evident within particular domains of management, stating, '*traditional marketing is ... a bit stuck in the heritage corner where you see ... many old-school Marketing Directors really struggling with the new digital world*' (Informant 14).

The uncertainty facing firms was widely felt, as was the recognition that boards are struggling '*to change their organisations as quickly as they need to*' (Informant 7). Many were facing up to '*a time of real change, a time when the whole market's changing the way it buys and thinks about things*' (Informant 13). Balancing the need for BD to become integral to how organisations operate, while managing uncertainty during these times, was a recurring issue:

Clients can't pause their companies ...we assume there's a moment in time, when someone goes: 'I've got it. I'm going to change my company and I'm going to put my company on pause, and everything is going to be fine'. But, of course, they can't because the next second, they need to sell something using the existing system and existing organisation. (Informant 7)

Temporal issues. Starting with the first temporal clash, informants acknowledged the speed of BD and welcomed the capacity to do things faster, ‘...we’ve done projects before now within six weeks, end-to-end – so go in, get the data, put into a platform, play about with it with analytics, segment the database, come up with a cluster segmentation, then build some models, and ... test them in six weeks’ (Informant 9). The additional benefits of being able to capture insight in the present rather than *post hoc* were also mentioned. Indeed, another informant reiterated this made it possible to ‘...see things happening as [they’re] happening, as opposed to watching history’ (Informant 4). There was, however, a perceived mismatch between BD velocity and the capacity to respond quickly, reflecting a view that, ‘...the market doesn’t work on that timeline’ (Informant 9), thus again evidencing a danger of the data ‘growing much faster than the ability to analyse it’ (Informant 1).

Organisations responded to these tensions using various short- and long-term fixes. In the short term, being realistic about what BD could achieve was deemed important. Balancing the need to ‘...move from the mentality ... that digital will substitute face-to-face towards [a view that] digital will augment this face-to-face experience’ (Informant 10), was one way to manage. Informants spoke about using social media insights to make regular and minor modifications to their existing targeting strategy. Consequently, using BD in ways that align naturally with existing practices helped to smooth its integration. For example, the director of a food business – which routinely seeks feedback on new products – highlighted enhancements to the process using digital media, ‘In two weeks I’ve got 50 videos on how consumers have used the product, what they think, what they like, what they don’t’ (Informant 11).

Moving to the second time-based clash, although BD can also capture past or present insights about a variety of phenomena, our data show a tension with strategy-making which is future-focused, *'It's a hindsight thing, and strategy is a foresight and intuitive thing'* (Informant 3). We found evidence that this led to confusion about when a decision should finally be fixed, partly because of the perceived need to *'continually go back to the data, trying to understand what it was saying now'* (Informant 13).

Board composition issues. Many informants were acutely conscious of not having grown up with Big Data, regarding it as the domain of *'tech happy people'* in their 20s or 30s. In contrast, *'very few board members [are] under the age of 45 or 50'* (Informant 2), with many firms seen as *'focused on 1980s principles'* (Informant 13). Even so, the need for boards to take responsibility in the face of these challenges was clearly evident, as was the need to remain pragmatic:

Boards cannot absolve themselves of responsibilities, of understanding their business, their market, and the decisions they need to make ... because in the end all Big Data gives them is a slight move, if you like, from 40%, to 50%, 60%... they'll never get beyond the 70%. So I think all that Big Data does, if you want to be brutally honest about it, is move you faster and closer to the 70%, you still have to make a decision based on imperfect information.
(Informant 3)

This view was tempered by scepticism about the extent to which BD will change existing practices, as the following director commented, *'I don't see anyone holistically changing their entire organisation, as a result of data'* (Informant 7). Another explained:

I'm not sure how having this huge knowledge bank of information will absolve or make it a great deal easier in making some of these big strategic decision;

you're still going to have to bring your own intelligence, interpretation, your own views on the future. (Informant 3)

Several others felt that irrespective of the advances in BD, the rational process of making decisions remains largely unaltered; BD was not considered to be a strategic panacea. One informant spoke of still needing ‘*decision-making [that] is ... logical and pragmatic*’ (Informant 13); while others saw the board occupying a position hovering above and, to some extent separate, from BD issues:

... a lot of the CEOs and FDs that we know ... they see themselves as making decisions standing back from all the noise and saying, we sit above this, we can see all this data coming in, we've got to make sure we just don't go down the wrong route. (Informant 1)

What I observe is that organisational politics at the highest level in companies are what drive it and it's who trusts whom, and what the agendas are. I think if you look at the very top. I don't think that's changed that much at all.
(Informant 13)

Among the suggested solutions for tackling these difficulties, were the creation of new directorships, recruitment of those with suitable technical skills, restructuring of the board, or outsourcing BD to ensure the necessary data resource and technical capabilities were in place. This finding links to our third core category of *Responsibility and Control*.

4.3. Third core category: responsibility and control

Our data evidence the ways in which boards seek to re-configure themselves as well as their relationships with key stakeholders as a response to the decision-making

demands BD placed upon them. This finding is confirmed by secondary data, in which some companies predict that new cross-industry partnerships will be established to benefit from the added value of big data. Some corporates are therefore failing to seize the opportunity that BD offers to improve their internal structure and to more effectively liaise with key stakeholders. This raises questions which highlight and potentially re-frame longstanding issues directly related to the board's *responsibility* and degree of organisational *control*. Two sub-themes emerge in relation to this issue. The first revolves around attempts to break-down existing functional 'silos'; sometimes and most notably accompanied by the establishment of sub-groups or sub-boards. The second relates to the outsourcing of responsibilities while working with external stakeholders. Both themes highlight significant implications for strategic decision-making.

The organisational impact of sub-group formulation. The impact of sub-group formulation emerged as a prominent finding within our data. While informants did not suggest that boards are holistically changing the structures of their entire organisations as a direct result of BD, many commented on the need to create new senior roles to make the necessary connections during this transformational period. As one informant noted, '*there's a route to the board that ... we've seen Chief Science Officers, Chief Data Science Officers, Chief Analytical Officer emerging in organisations*' (Informant 9). Indeed, secondary data confirms that a few companies are hiring new experts in BD in order to develop new technology and design innovative BD infrastructure. These new employees are typically in senior management roles located within a big data team that is likely to support board decision-making. When explaining this development, informants particularly noted that, '*the technology [involved in processing BD] ...*

determines what is possible and, therefore, the creativity [lies] within the constraints of technology in a way that it was less so in the past' (Informant 8). This effect is having a major impact upon how the board functions and responds to the assimilation of knowledge acquired through the interpretation of BD. For example, as another informant explained:

[bringing] a different set of people into the business [provides] no visibility of how a business operates. All they understand is the part of the organisation they've built ... [and yet] those people with that business knowledge, they're the people that are actually the powerful people. (Informant 9)

This respondent suggested that the damaging consequences of these actions throughout middle-management teams were apparent, using the following illustration, *'This is basically going to make the guy in ops look bad, so I need to ... inform him this is what's happened and we need to work out a joint messaging strategy, so that when he's in the room he doesn't stand up and challenge what we've done'* (Informant 9).

The problems raised by these developments are seldom documented in academic research at the board level, but the strategic implications are clearly exposed; something which informants were quick to signpost as a destructive impact of the board's response:

They've got someone called Head of Customer, but everyone else reports into the Sales Director, so she's Head of Customer and the Sales Director then has Marketing, Shops, IT, Product all reporting to him... That's not going to work. They've done it, so they've appointed someone, but they haven't changed the organisation, so they all sit cross-armed, and she will probably leave after a year and a half, and then they'll get another one. (Informant 7)

External stakeholders. The second sub-theme, which underpins the core category of *responsibility and control*, exposes a trend towards the outsourcing of resource to external stakeholders. A number of informants, through their roles providing external consultancy support, felt that their clients depended heavily on these outsourcing relationships. Perhaps more importantly, as the following comment highlights, boards may be losing control of their influence over the firm's strategic direction as a result, *'When it comes to the board ... they totally rely on us [external BD provider]'* (Informant 4). Reinforcing this position, another informant added:

I suspect a lot of boards are very reliant on consultancy advice actually and are probably getting information second-hand. You can't particularly blame the board directors for that because it's not their area of expertise, and that adds to risk ... And it does strike me that the people running business are in quite a weak position and not always often able to embrace some of these changes. (Informant 2)

In this respect, our data reveal the involvement of a broad range of stakeholders in shaping how BD is transforming learning and action, particularly regarding how those decisions are made. An informant admitted that, *'what I've learnt over the last few weeks is that you have to go back and engage with that audience and you need to show them the successes that you've achieved'* (Informant 19). Organisations ground many of their beliefs about the ways that BD might be used by observing other industry players. As one informant noted, *'We've nicked a few ideas from other distributors that were doing quirky things...'* (Informant 15). Organisations often recruit experts from other firms as a way of building their capabilities. They often rely on third parties: firms which already have the required resources to support them. These trends highlight the

important distinction between BD (i.e. data as a resource) and the organisation's analytics capabilities, as the following informant suggests:

I'm talking about them having the resources to analyse the BD that they get from the data crunchers, because gathering, shaping, analysing, or rather, presenting the results of BD, seems to be the preserve of outsourced organisations. (Informant 3)

Such an approach does not evolve without concerns for many organisations; not least, as one informant suggests, regarding whether sharing data is tantamount to giving information away, *'They're worried about ... giving away intellectual property'* (Informant 4). One informant involved in gathering data on behalf of clients elaborates:

We've got to the point now where we're using their model on our machines with our data, rather than us giving our data to them to run on their machines. But that issue of potentially inhibiting our independence has been, I think, the biggest stumbling block for us to think about. Why we would partner with someone else? (Informant 6)

5. Discussion and conclusions

In this empirical paper, we set out to explore whether BD has changed the process of board level decision-making and, if so, how and to what extent. The study contributes to knowledge by pointing to areas for development relating to the core categories at each of the three levels of our analysis. At the level of the individual directors, we identify a gap in the cognitive capabilities that organisations possess to cope with BD; capabilities that are crucial in avoiding the cognitive biases and overloads to which BD can contribute. Second, at the level of the board itself, we find board cohesion is disrupted by BD, which has consequences for the decision-making process itself. As

directors struggle to introduce changes within the shortened timescales created by an ever-changing backdrop of new data, they are under pressure to adapt the way strategic decisions are made. Third, taking a holistic view of BD's impact that encompasses the whole organisation and its external stakeholders, we find boards seeking new ways of working that cut across traditional 'silos', such as through the introduction of sub-boards, and relying upon the capabilities of third parties to help handle BD. These three points highlight a shortfall in capabilities for dealing with the challenges of BD. Boards therefore need to develop their cognitive capabilities at an individual level; find new ways to make strategic decisions to meet the temporal and other challenges BD brings; and work in new ways, both across the organisation and with external stakeholders who have valuable BD capabilities. In the remainder of this section we explore each of these issues in more detail.

First, we note that our theoretical approach, drawing on a capabilities perspective and the KBV, played an important role in this study. This perspective was particularly suitable in helping the researchers to make sense of our findings, which can be summarised as referring to a need and appetite for new capabilities; explaining the impact of excess knowledge and information on the strategic decision-making process; and highlighting how BD can provide opportunities to enhance firms' adaptive capabilities. The KBV implies that the more knowledge the organisation possesses, the greater the opportunity to maximise competitive advantage. By supporting the KBV approach with the concepts of dynamic and cognitive capabilities, we reveal the need to develop a wide range of abilities to respond rapidly to the changing environment (Nonaka & Takeuchi, 1995; Eisenhardt & Martin, 2000). However, while the KBV suggests knowledge is a vital resource (Leonard, 2011; Grant, 1996) that depends on the amount of (big) data and information a decision-maker can obtain (Zahra &

Filatotchev, 2004), it does not explain the impact of excess knowledge and information. In relation to our first research question to explore the impact of BD for individual directors, our results show a potential negative impact on capabilities with particular consequences for individual directors, where an excess of data causes a ‘cognitive overload’ for the board. Such ‘cognitive overload’ can lead to ‘information overload’, with the result that an excessive level of information does not necessary yield improved competitive advantage because decision-makers are unable to process significant amounts of the data.

In the context of the KBV, dynamic capabilities allow a company to modify resources to respond quickly to environmental changes (Côte-Real et al., 2016). Helfat and Peteraf (2015) find that cognitive capabilities explain why some corporate decision-makers have more effective capabilities than others in this respect. However, the way knowledge is used to anticipate and respond to an evolving BD environment remains unclear. Our results suggest that decision-makers use BD as a knowledge source in different ways. Some board directors appeared not to recognise the value of BD as a resource or have the necessary in-house analytical skills to manipulate it, with the result that they did not have a key role for BD in the firm’s decision-making process. In other instances, such as where directors could see BD’s potential to add value through the provision of new knowledge about the firm’s environment, the benefit of having up-to-date information was more likely to be acknowledged. In the latter case BD is seen to occupy a pivotal position, in that it has a direct relationship with the firm’s decision-making processes, with the potential to transform the ways in which the organisation functions.

Moving on to our second research question which sought to establish BD’s impact on how the board works, we found several ways in which there was potential to

transform corporate governance processes and organisational decision-making (Fosso Wamba et al., 2015; Janssen et al., 2017). First, as well as triggering the capabilities of individual directors (Erevelles et al., 2016; Côte-Real et al., 2016), we found BD becomes part of the set of capabilities that a company and decision-makers need to be successful (Braganza et al., 2017). The findings therefore show that as a potential source of knowledge BD should be influencing both the dynamic capabilities of the board and the wider organisation, as well as the cognitive capabilities of the individual directors. Regarding organisational functioning, in order to efficiently utilise BD, we suggest firms will benefit from strong internal co-ordination and integration, along with a common BD culture amongst decision-makers. In some instances, we found organisations responding to the challenges of BD with inertia; but we also saw examples of positive in-house responses (i.e. building internal capabilities) and of seeking to work with external stakeholders (i.e. outsourcing selected BD activities).

The speed at which decisions need to be made within a BD context places further pressure on the process. Nonaka and Takeuchi (1994; 1995) use the term “spiral” to describe a four-stage dynamic, interconnected process of knowledge conversion, termed *socialisation*, *internalisation*, *combination* and *externalisation*. Considering BD in this light, while the levels of knowledge these authors identify (*individual*, *group*, *organisation* and *inter-organisation*) are clearly reflected in our analysis, the issues of time pressures that were so strongly expressed are not explicitly addressed in detail in the KBV literature. Organisations that can build the capabilities to make strategic decisions rapidly and embrace the tensions that can arise from creating forward-looking strategies while reviewing backward-looking data, are more likely to make effective progress with BD.

Turning to our third research question addressing BD's wider impact on the organisation and its external stakeholders, we observed changes in how, and with whom, boards are working. These changes indicate that firms need to proactively address changes in their external environment; including using signals from stakeholders (Erevelles et al., 2016) to predict changes in current needs (adaptive capability) and possible future demands (Day, 2011; 2014). When successfully applied, BD provides opportunities to enhance firms' adaptive capability. Within the KBV theoretical framework, however, it is still unclear how the interaction with stakeholders supports the creation of resources and building of capabilities. We suggest that the activities of key stakeholders such as competitors can encourage firms to develop new capabilities in using BD. There is certainly evidence that stakeholders such as consultancy companies and digital experts can provide additional external resources to support decision-making in focal firms. Policy-makers and other stakeholders may be able to educate companies about BD's role in improving the speed and efficiency of decision-making. Therefore, we argue that organisations adopting a stakeholder-oriented view may find these relationships an important resource for achieving and sustaining knowledge-based advantage. With the increasing importance of knowledge-based capabilities, we suggest coping effectively with stakeholders with the power to incentivise firms to develop additional knowledge, is fundamental.

6. Limitations and a future research agenda

This study is based on rich data gleaned from lengthy interviews gathered at board level in a range of UK-based, global organisations. A distinctive feature of the paper is a rich dataset, based on a senior level of organisational access, that has helped us to

unpack complex issues surrounding how strategic decisions are made by boards and how directors respond to the challenges which arise as a consequence.

While this research provides important insights into BD and the decision-making process, the findings should be considered in the light of the limitations of the study. First, being a qualitative study, the generalisability of the outputs is limited given the nature of the sample (e.g. Musteen, 2016). We also note that, as in any qualitative study based on interviews, our respondents may have a personal agenda (e.g. Jakobsson & Akerstrom, 2013). However, the generalisability of our findings is not a quantifiable intention of this study; and our approach is theoretically and methodologically consistent with the nature of the research problem, which requires in-depth insight into a complex real-world situation.

Our findings contribute a cross-sectional view of the problem, and we therefore suggest that further research should examine the differing impacts of BD on board level decision-making across a range of firm types and industry sectors. Our research also reveals that there is scope for a more nuanced understanding of the extent to which the findings are influenced by contextual factors such as firm size and industry, and the nature of the business and of the strategic decisions taken. In this vein, future research could further unpack the relationships between BD's growth and the corporate governance processes of affected organisations. Longitudinal case studies, for example, could paint a richer picture of the developments in some organisations to build their cognitive and dynamic capabilities, to respond to the temporal challenges of strategic decisions in the BD era, and to work effectively with external stakeholders to address gaps in internal resources and capabilities. Such studies could further enhance the contribution of this research, which has adopted the perspective of capabilities and the KBV to explain why and how directors and the board, in an era of BD, should develop

a wide range of capabilities to rapidly respond to environmental changes while anticipating stakeholder needs. Our contribution at all three levels – individual directors, the board and the organisation/stakeholder – are worthy of further investigation.

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Appendix A: Semi-Structured Key-Informant Interview Template

Research Question:

Has 'Big Data' changed the process of board level decision-making, and if so how and to what extent?

1. Project Background

- Informants to be given an explanation of the project, focusing on brief background and aims

2. Respondent Background

- Their current/previous roles/remits.
- Their board-level experiences.

3. The Context of 'Big Data'

- Are there differences between sectors in the use of the data?
- Does organisational size matter?
- Does having access to a lot of data provide competitive advantage? Or is what matters how organisations use the data they gather?
- Do boards find it difficult to become 'tech savvy' and if so, why?
- Does data force you to look backward more than it does forward in decision-making?
- 'Big Data' is constantly streaming; is a danger of losing the overall narrative (strategy)?

4. Complexity and Uncertainty

- Does digitisation (and all data in electronic form and easily accessible):
 - Increase or reduce uncertainty?
 - Reduce the likelihood that decision may go wrong?
 - Increase/Decrease the number of alternatives considered?
 - Increase/Decrease the number/diversity of stakeholders involved?
 - Increase/Decrease the influence of internal/external stakeholders?
 - Allow greater intervention into the process by stakeholders?
 - Increase/Decrease confidence in information sources?
 - Increase political infighting as different factions fight their corner with greater amounts of information?

5. Reflecting on the Decision-Making Process

- Does 'Big Data':
 - Speed up/slow down the time it takes to make a decision (authorisation and implementation)?
 - Mean there are more re-cycles and re-visiting of problems?
 - Make the process more or less formal/restricted to senior management teams?
 - Make the decision process more fluid and continuous?
 - Vary from decision to decision – i.e. some decisions use digital data to a much greater extent than others? Can you give an example?
- In what ways have the insights used in decision-making changed? For example, the types of data used, data providers, providers of analytics, and the parties involved in providing these insights.

6. Reflecting on the Governance Process

- Does 'Big Data':
 - Mean the Board works more effectively and efficiently?
 - Put greater demands on the Board to examine and analyse information?
 - Help or hinder competitor analysis?
 - Reduce the incidence of hunches and gut feel?
 - Increase or decrease accountability of the board/top team?
 - Influence the kinds of directors who are elected to the board (e.g. execs and non-exec)?

7. Closing Questions

- Which other organisations are driving the agenda in this area?
- Who else should we contact?

TABLES

Table 1

Informants and Organisations.

Informant	Informants' Role	Company Details	Sector
Informant 1, Company A	Senior Manager	Independent consultancy company in corporate, institutional, wealth management and corporate sectors. Turnover: over £310k (2016). No. of employees: less than 50 (2016).	Consultancy
Informant 2, Company A	Consulting Director		
Informant 3, Company B	Executive Director in Marketing, Sales, Strategy and Commercial	A leading learning and development supplier. Turnover: over £24m (2015). No. of employees: over 270 (2015).	Professional and Technology services
Informant 4, Company C	Chairman	Leading landscape intelligence analytics company. Turnover: over £1.9m (2016). No. of employees: less than 50 (2016).	Database Software
Informant 5, Company D	Managing Director	Insurance brokers for commercial and private customers. Turnover: £320K (2016). No. of employees: less than 50 (2016).	Insurance Broker
Informant 6, Company E	Director of Marketing	Large gambling and gaming business. Turnover: £1.6bn (2015). No. of employees: over 16,000 (2016).	Gambling
Informant 7, Company F	CEO	Worldwide leader in professional services. Turnover: over £ 23bn (2016). No. of employees: over 230,000 (2016).	Professional Services
Informant 8, Company G	CEO	One of the world's leading marketing agencies. Turnover: over £12bn. (2015). No. of employees: almost 190,000 (2015).	Advertising and Public relations
Informant 9, Company H	Senior Manager	Global agency specialising in strategy, consulting, digital and technology services. Turnover: £26.73 bn. (2016). No of employees: 394,000 (2016).	Professional and Technology services
Informant 10, Company I	Senior VP Marketing	One of the top five European insurance businesses. Turnover: over £80bn. (2015). No. of employees: over 142,000 (2015).	Financial services
Informant 11, Company J	Chief Marketing Officer	Leading food manufacturer. Turnover: over £106m (2015). No. of employees: over 250 (2015).	Food and beverages
Informant 12, Company K	Co-founder and Head of Insight	Leading futurologists and trend forecasters in the UK, with operations in North America and Europe. Turnover: over £7.7m (2015). No. of employees: less than 50 (2015).	Professional and Technology services
Informant 13, Company L	Head of Marketing for Cloud and Strategic Solutions	Top 5 global IT services provider, operating in 100 countries. Turnover: over £30bn. (2015). No of employees: over 150,000, of which 14,000 in the UK (2015).	Computer and IT

Informant 14, Company M	Global Head of Data and Sciences	One of the top five global market research organisations. Turnover: over £ 1.2bn (2016). No of employees: over 13,000 (2016).	Market Research
Informant 15, Company N	General Manager	Global software provider with over 150 distributors and sales offices. Parent company turnover: £21billion (2016). No. of employees: over 160,000 (2016).	Industrial software
Informant 16, Company O	Head of New Propositions and Strategy	One of the biggest phone retailers in Europe. Turnover in the UK: £2.9bn (2016). No of employees: 42,000 in 11 countries (2016).	Telecommunication
Informant 17, Company P	Head of Marketing	Global Digital Agency operating in Europe, US and South Africa. Turnover: £38m (2016). No. of employees: over 500 (2016).	Professional and Technology services
Informant 18, Company R	Head of UK Business Development	One of the largest producers of transformer oils and bitumen for paving and industrial purposes. Turnover: £ 15bn. (2016). No. of employees: over 900 (2016).	Oil and Gas
Informant 19, Company S	Head of Business Development	Leading manufacturer of building materials. Turnover: £ 4.4m (2015). No. of employees: over 500 (2015).	Manufacturing
Informant 20, Company T	Propositions and Marketing Director	One of the largest business process outsourcing and professional services. Turnover: £ 4.8 (2016). No. of employees: over 70,000 (2016).	Professional services

Table 2
Sub-Themes and Core Categories.

Example Quotations	Sub-Themes	Core Categories
<ul style="list-style-type: none"> • “What’s available has increased, and the number of sources has increased, and that requires a more sophisticated set of skills to sort and prioritise.” 	<p><i>Shortfall in cognitive capability</i> (88 quotations)</p>	<p><i>Cognitive capabilities</i> (177 quotations)</p>
<ul style="list-style-type: none"> • “...you suddenly know whether you’re talking to a bunch of people that truly have their finger on the pulse of what’s driving their business, or whether they’re in ‘cloud cuckoo land’.” • “I’m not sure that the boards ever really get to grips with Big Data.” • “I don’t think you’ve got enough hours in a day to solve these problems.” • “There is too much of it [BD] to really be able to analyse effectively.” 	<p><i>Cognitive biases</i> (58 quotations)</p> <p><i>Cognitive overload</i> (31 quotations)</p>	
<ul style="list-style-type: none"> • “They start panicking at that point and hyperventilating, because the organisational change that’s required for them to get that done is huge,” • “No integration of technology, no integration of database, but lots of very rich middle-aged men [on the board], clinging onto their very important jobs for dear life.” 	<p><i>Decision-making disruption</i> (53 quotations)</p>	<p><i>Board cohesion (113 quotations)</i></p>
<ul style="list-style-type: none"> • “...the market doesn’t work on that timeline.” • BD is “growing much faster than the ability to analyse it.” • “I don’t see anyone holistically changing their entire organisation, as a result of data.” • “I’m not sure how having this huge knowledge bank of information will absolve or make it a great deal easier in making some of these big strategic decisions.” 	<p><i>Temporal issues</i> (39 quotations)</p> <p><i>Board composition issues</i> (21 quotations)</p>	
<ul style="list-style-type: none"> • “...they haven’t changed the organisation, so they all sit cross-armed, and she will probably leave after a year and a half, and then they’ll get another one.” • “When it comes to the board ... they totally rely on us [external BD provider].” • “They’re worried about ... giving away intellectual property.” 	<p><i>Organisational impact of sub-groups</i> (24 quotations)</p> <p><i>External stakeholders</i> (61 quotations)</p>	<p><i>Responsibility and control</i> (85 quotations)</p>