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Towards An Understanding Of The Role Of Business Intelligence Systems In Organizational Knowing

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Abstract

Advances in information technology (IT) have increased the ability of organizations to collect and analyze intelligence to support decisions. Over the last two decades the concept of business intelligence (BI) and actual BI technologies have gained prominence. Recent studies provide evidence of increased organizational productivity as a result of BI systems use. There is little focus to date, however, on how BI systems might play a role in the process of organizational knowledge creation. We develop a conceptual framework of organizational knowing, and use this conceptualization to analyze data gathered from a case study. We investigate how BI systems facilitate the process of knowledge creation – knowing – in organizational settings. We find that the ability of BI systems to provide a solid foundation of facts, combined with their capability to enable users to "drill down" and "roll up", are important for the active process of knowing in organizations. More specifically, we identify two cyclical processes triggered by BI systems that distinguish them from prior applications of IT, namely: the power 1) to initiate problem articulation and dialogue, and 2) of data selection, for example, to address information needs of organizational decision makers at different managerial levels. We show that, while BI data do not fully determine action, they play a central role in discussions, reflections and negotiations, thereby facilitating the process of organizational knowing.

Keywords: Business Intelligence Systems, Organizational Knowing, Interpretive Case Study

1 Background: The advent and Impact of BI Systems

Recent advances in IT to provide business intelligence (BI), combined with the on-going financial and economic crisis, magnifies the criticality of decision-making in an increasingly competitive and worryingly adverse business environment. As a consequence, the concepts of "big data", data analytics and the use of BI technologies have gained prominence (e.g., Davenport, et al., 2012). For example, major consultancies, such as McKinsey & Company, see big data – the ability to analyze large data sets – as "the next frontier for innovation, competition, and productivity".[i] For several years now, BI spending has increased in comparison to the IT budget overall overall: just last year, BI expenditure saw an increase of $10.5 billion worldwide while IT budgets have been kept flat (Gartner, 2011). Luftman and Zadeh (2011) identified BI as the most influential technology in organizations. At the same time, Brynjolfson et al., (2011) provide evidence that the adoption of BI technologies leads to a productivity increase of between 5 and 6%. BI systems appear to play – or at least have the potential to play – an increasingly important role in organizational decision-making therefore. But what do we know about the nature of the role BI systems might play in organizational decision-making? Little research to date has been undertaken to answer this question.

From the literature that does exist, we identify two parallel perspectives as to how researchers view the role of BI systems in organizations. First, there is what might be termed a traditional view that sees BI systems' primary role as the transformation of raw data into information, and of information into knowledge: to make better decisions. A common premise is that BI systems and related technologies (e.g., enterprise and knowledge management systems) create new insights and organizational knowledge that ultimately leads to better decision-making (Cheng et al., 2006; Clark et al., 2007). Second, and conversely, such systems have been criticized for focusing mainly on technology at the "expense of people" (Swan, et al., 1999; Shollo & Kautz, 2010). Galliers and Newell (2001) argue for "refocusing attention" on the importance of *people* in the process of knowledge creation – in *organizational knowing*. Despite the recent attention being paid to BI and big data, there is little focus to date on *how* any transformation from data to organizational knowledge may take place, and how BI systems might play a part in this process. We seek to investigate the role of BI systems by examining how BI facilitates knowing in organizational settings. We do so by conducting an interpretative case study in a financial institution. We first provide a brief history of the evolution towards the BI systems of today. Then, we juxtapose the two aforementioned views on the role of BI systems (and more broadly on the role of IT), in knowledge creation. We then surface the assumptions underpinning the two views. The research design and methodology is then described, followed by a presentation of the findings. We conclude with a discussion, identifying implications for practice and future research.

2 Context – IT and Management Decision-making

The development of the mainframe computer in the 1950s led to the development of data processing systems, and, in turn, management information systems (MIS) – systems designed to support managerial decision-making. From the mid-1960s, mini computers marked the birth of decision support systems (DSS), and subsequently executive information systems (EIS) (Somogyi & Galliers, 1987). The latest in this line of technologies, introduced as an aid to managerial decision-making, are BI systems. BI systems are integrated systems that are linked to a data warehouse and other BI applications, and are designed to facilitate the analysis of stored (real-time and historical) data in support of managerial decision-making (Davenport, 2006). Developments in technological aids to managerial decision-making are summarized in Table 1, below.

BI systems differ from their predecessors in that the provision of fact-based information is enabled by the integration of different systems from different business domains. The idea is that these may provide new insights that will lead to better decisions. BI systems consist of processes, technologies and applications that are meant to enable organizations to gather, store, analyze and transform data into information which is relevant for decision-making (Wixom & Watson 2010; Davenport 2010). Recently, Brynjolfson et al. (2011; 1) found that firms that adopt BI systems have, "output and productivity that is 5-6% higher … [compared to] … other investments and information technology

usage." We now consider the concept of BI and provide an overview of the two perspectives on BI and knowledge creation, prior to considering the role of BI systems in organizational settings.

Development Era	**Management support systems**	**Purpose**	**Illustrative References**
Mid 1960s	Management Information Systems	Provided structured, periodic reports, information to support structured decisions	Amstutz 1966; Ackoff, 1967;
Late 1960s	Decision Support Systems	Decision related information to support semi-structured or unstructured decisions	Scott 1967; Scott 1968;
Early 1970s	Model-based DSS	Optimization and simulation models to improve managerial decision-making	Scott-Morton 1971; Gorry & Scott 1971
Late 1970s	Document-based systems	Enabled document search to support decision- making	Swanson & Culnan 1978
Late 1970s	Executive Information Systems	Provided predefined information screens for senior executives	Rockart 1979
Early 1990s	Data warehouse systems	Large collections of historical data in organizational repositories enabling analysis	Inmon 1992; Kimball 1996
Early 1990s - 2000s	Knowledge Management Systems	Managing knowledge in organizations for supporting creation, capture, storage and dissemination of information	Akscyn et al. 1988; Leidner 2000
2000s – present day	Business Intelligence Systems / Business Analytics	Decision support linked to analysis of large collections of data based on integration of different systems and data sources	Dresner, 1989; Watson & Wixom 2010

Table 1. The evolution of systems designed to support managerial decision-making.

3 Current Perspectives on BI and Organizational Knowing

In an attempt to unpack concepts underpinning BI and organizational knowing, we first look at the nature of intelligence. Current studies define BI as a process, product and technology (Clark et al, 2007; Wixom & Watson, 2010). In these studies, BI is seen as a *continuous* process: data are *gathered* and *stored*, then *transformed* into information by *analysis*. This information is then *transformed* into *knowledge* to support *decisions*. According to this view, *technology* is an important catalyst in the development of BI because it is the *integration* of different technologies that enables and continues to facilitate BI. In this view, BI systems are seen to *create* knowledge useful for decision-making. *How* information is transformed into knowledge it is not addressed, however. This perspective is similar to traditional views of enterprise systems and knowledge management systems (KMS), where these systems are assumed to be solutions that enable the translation of data into information and, ultimately, knowledge – the so-called information and communication technologies (ICT) perspective (Newell et al., 2002). As was the case with knowledge management (Scarbrough & Swan, 2003), a literature review on BI (Shollo & Kautz, 2010) shows that the topic has been addressed by IS journals almost exclusively, and driven by IT specialists, consultancy firms and management 'gurus'.

The ICT perspective has been criticized for overemphasizing technology and devaluing the human processes of sense-making (cf. Weick, 1995) and knowing in organizations (Davenport 1996; Swan et al., 1999). Galliers and Newell (2003) draw attention to data which are context-free and often located in IT systems, but made sense of by the application of personal knowledge to become informative, in a particular context. Here, the claim is that technology may *facilitate* the transformation of data into knowledge but certainly does not *enable* it, thereby calling into question the very notion of *knowledge* management systems. The ICT perspective views knowledge as an "objectified commodity" that can be transferred "as-is" from one point to another (Gherardi, 2000). The second, human – sense-making or 'knowing' – perspective claims that BI systems may *facilitate* the transformation because knowledge creating and learning is primarily a social and participative activity (ibid.).

The above views thus boil down to differing conceptions of knowledge and its creation in organizational settings. The ICT perspective sees knowledge as commodity, providing the basis for

effective business activities (Grant, 1996). This view of knowledge has its roots in the knowledge-based view of the firm where knowledge is viewed to have a positive correlation to organizational performance (Swan, 2003). The knowing perspective contests these underlying assumptions concerning the nature of knowledge as a commodity or resource (e.g., Blackler, 1995). For example, there is an on-going debate concerning the codification of knowledge (i.e., making tacit knowledge explicit). Explicit or codified knowledge refers to knowledge that is documented; captured; stored, and retrievable, and that is transmittable in formal, systematic language (Nonaka, 1994). The "encoded knowledge" – from Blackler's (1995) typology of knowledge – and "leaky" knowledge (Liebeskind, 1996), fall into the explicit category. This type of knowledge is viewed as a tangible object, "conceptually distinct from the material technologies around which organizations are structured" (Blackler, 1995; 1039). According to Newell (2002; 106), this conception of knowledge, "adopts a cognitive information-processing view where knowledge located inside people's heads or in organizational practices is identified, captured and processed via the use of ICT tools so that it can be applied in new contexts." Pozzebon and Pinsonneault (2012) label this as the knowledge "possession view" – a view shared by adherents to the 'ICT perspective': technologically-focused and knowledge-based (Galliers & Newell, 2001; Newell, 2002).

Those who adhere to the 'knowing perspective' contest the assumption that knowledge can be commodified and see what ICT can accomplish in this regard often as an over-estimation (Gherardi, 2000; Marabelli & Newell, 2012). They argue, following Polanyi (1958), that knowledge has a personal quality, which makes it hard to formalize and communicate. Szulanski (1996) notes the "sticky" nature of knowledge – evident in what are often unsuccessful attempts to transfer knowledge from one (part of) an organization to another. As Tsoukas (2003; 3) argues, "knowledge-based economies may make great use of codified knowledge, but this is inescapably used in a non-codifiable and non-theoretical manner." Classifying knowledge along these lines is helpful but problematic, however, since, in practice, the types overlap and interact, making their boundaries unclear (Brown & Duguid, 2001; Blackler 1995). There is also a static quality to such classifications, which undermines the social nature of knowledge creation in organizations. To avoid such issues (i.e., in terms of viewing *knowledge* as something that is *possessed*), *knowing* has been proposed as something that people *do* (Cook & Brown, 1999; Blackler, 1995). Knowing is rooted in practice and experience, where organizations are viewed as systems of practices in a world of tacit knowledge (Gherardi, 2000; Kolb & Kolb, 2005). Experiential learning theory also views knowing as "the process whereby knowledge … results from the combination of grasping and transforming experience" (Kolb, 1984; 41). Thus, knowing incorporates all knowledge types in the Blackler typology: it is tangible (encoded) and intangible (embrained); action-oriented (embedded; embodied), and environment-specific (encultured).

Kolb's description of organizational knowing is in line with the views of Polanyi and Tsoukas in that knowledge creation starts from an individual's immediate or concrete experiences (Kolb & Kolb, 2005). These form the basis for observations and reflections, which result in new distinctions that are assimilated and distilled into abstract concepts from which new implications for action can be drawn through negotiation. "When new distinctions are made and accepted, new organizational knowledge emerges and when the new distinctions are developed into new products or processes, or are embodied in new actions, innovation and learning … occur" (Tsoukas, 2009; 2). Thus, we summarize the concept of knowing as "an active process" of making new distinctions accepted in organizational settings and embodied in organizational changes, from which learning occurs. We acknowledge that Figure 1 does not capture the full extent of the complexities of *knowing*. While a simplification, it nonetheless captures the essence of the above arguments, and was used as a sense-making (cf. Weick, 1995) device to organize the field data we collected, and its subsequent analysis.

To study knowing as something that people *do* means to analyse the dynamics of the socio-technical systems through which knowing is accomplished. It is mediated by language, technology, collaboration and control; is situated in particular contexts (time and space); is provisional (because it is constantly developing), and is pragmatic (in terms of serving a specific purpose (Blackler, 1995). This is the conceptual basis for our study. In it, we investigate how knowing is mediated by IT, and

more specifically, by BI systems. Thus, we conducted an interpretive case study to examine how BI systems mediate knowing in organizations as a precursor to managerial decision-making. More precisely, our research question is: *How does BI facilitate knowing in organizational settings?* Based on the above discussion, we derive three sub-questions: *How does BI facilitate the emergence of new distinctions? How does BI facilitate the emergence of organizational knowledge? How does BI facilitate organizational actions?*

Figure 1: Knowing as an "active process"

4 Research Design and Presentation of the Case Study

The empirical basis for this research was a case study that investigated the role and the use of BI in a successful Scandinavian financial institution, given its high market share. The study was conducted in different units of the organization (e.g., business units, the IT unit and branch offices with direct client contact). The company was chosen as it uses state-of-the-art IT to support and improve decision-making. Branch advisors, their managers and the BI analysts use BI tools (e.g., Query Analyzer; performance management systems; Excel spread sheets) to perform a range of data analysis.

We conducted ten interviews initially with key personnel in the organization, and two with external subject experts. These were followed by further interviews roughly two years later in order to obtain insights into the use and impact of the BI system over time. Background information was also collected (e.g., organization charts; reports; spreadsheets; forms; presentations; memos, and meeting minutes). Those interviewed used BI in their everyday work and represented different managerial levels. The form of the interviews was semi-structured, based on an interview guide. The interviews started with demographic and open-ended questions, followed by questions focusing on the interviewees' daily work and use of BI systems. Each interview was conducted in English in the interviewee's office and lasted an average of 60 minutes.

When reviewing the interview transcripts and background materials, together with field notes that had been taken to record our impressions at the time of each interview, we looked specifically for indicators of how BI was used. We employed constant comparative techniques and open coding (Strauss, & Corbin, 2008). This was an iterative process during which we discussed codes until agreement was reached. The codes captured concepts such as "BI fosters dialogue" and "reflections on data". We captured 250 codes relevant to the role of BI in organizational knowing. As a result, the data-structure (Vendelø & Rerup, 2011) presented in Table 2 was developed. We organized these first order codes into data-tables that supported a single theme or topic across data sources (ibid.).

We sorted the data further by developing second order themes, using the three research sub-questions to sort through the first order codes. The process of developing the second order themes involved many iterative cycles. The codes were initially categorized into 16 themes, which after several iterations and discussions concerning the avoidance of overlaps, were reduced to five main themes. In a final iterative step – 'data selection' and 'articulation' and their relationship to "organizational knowing" – emerged as transparently observable phenomena (Eisenhardt, 1989).

First-order codes	Questions derived from Figure 1	Second-order themes	Aggregate dimensions
"use our common sense", "part of it", "based on knowledge"	How does BI facilitate the emergence of new distinctions?	Articulation of new distinctions	**Articulation**
"creates a dialogue", "creates a conversation"	How does BI facilitate the emergence of organizational knowledge?	Articulation of different perspectives	
"benchmarking", "learn from each other", "act on facts"	How does BI facilitate organizational actions?	Articulation of organizational actions	
"go down", "drill down", "overview", "patterns"	How does BI facilitate the emergence of new distinctions?	Data on demand	**Data Selection**
"need data to convince people", "show the right way"	How does BI facilitate the emergence of organizational knowledge?	Turning data into evidence	
"need facts, "all observations show the same"	How does BI facilitate organizational actions?		

Table 2: Data-structure from first order codes to final dimensions

5 Analysis

Our analysis, based on the data structure presented in Figure 2, is now presented. We start by recounting an illustrative story as a foundation for the presentation of our results. The story concerns branch advisors and loan price quotations they give to their clients: *"… in every region you have some branches that were quite good at taking the [set] prices [for a loan] but you had ... a lot [who] gave some sort of discount."* (Branch Performance Analyst, 2010). Thus not all advisors were complying with the rates set centrally, frequently giving discounts. Set fees are automatically calculated from the loan system according to a defined set of criteria. From 2000, the bank's strategy focused on lending growth. Pricing was not perceived to be a priority. Pricing across the country was reported by a Branch Performance Analyst (2010) as: *"… a lot of the regions [in the West of the country] ... gave … a higher discount than they do in and around [the capital] ..."*. The Branch Performance Analyst, in a follow-up interview (2012), described the situation in greater detail: *"First of all we said, 'Well, is there a difference between how advisers are pricing the loans?' So, we could see that at the regional level, yes, there were differences. [The capital] and the surrounding areas had higher prices than [in the West]... This made us look in more detail ... we could see there's a difference between branches in the same area. From that we said, 'OK, perhaps there's a difference between the advisers within the same branch.' The funny part was that we could draw the same curve on all levels."* Developing the latter point, and since the BI system enabled comparison across branches, the Branch Performance Analyst had previously (2010) said that, *"No matter which branch you took, you could draw the same curve. So you could say you have some advisors in the same branch ... who take the price every time and ... some advisors who give a discount every time. So what we actually learned … is that it's not a matter of marketplace, it's more about the advisor's behaviour and how he thinks about price."*

When asked about the timing of the BI analysis, the Branch Performance Analyst explained that, in the period 2008-2009, when the financial crisis hit the market, growth lending was not perceived to be a viable solution anymore. Hence, top management began to search for other ways to increase bank earnings. Middle managers were requested to bring suggestions to the table. According to the Branch Performance Analyst, the BI system *"made it possible to document [the analysts'] thesis"*. When asked about the role of the BI system in this re-orientation, he reported (2012) that: *"The analysis done on pricing using the BI tools has helped to develop the general strategy in the bank, changing the way that we price products in general."* This realisation spurred new discussions between the analysts, the branch managers and the advisors about sharing knowledge to improve price compliance. For example: *"So, actually, it's possible to change behaviour. So we had some meetings [and] what we actually achieved was to raise the bottom line [company's net earnings]. We've estimated that we made around €53 million on that."* (Branch Performance Analyst, 2010).

Summarizing then (cf. Figure 1), we could see that the performance analysts used the BI system to raise awareness amongst senior management and the branches about non-compliance with pricing

guidelines. Old beliefs were changed, through discussion and learning, and new distinctions and beliefs were formed and acted upon. We shall now consider our findings in greater depth.

5.1 Findings: The cyclical processes of data selection and articulation triggered by BI systems in organizational knowing

To investigate BI use in the process of organizational knowing and BI-use-in-practice (cf. Whittington, 2006), it is first necessary to understand the nature of the underlying processes of articulation and data selection that were triggered by the BI system. Articulation is the coherent communication process of one's beliefs, opinions and ideas. We found clear patterns of variations in how articulation was initiated by BI. The articulation process had three main themes: articulation of new distinctions; articulations of different perspectives, and articulations of organizational actions.

5.1.1 Articulations of new distinctions

New distinctions emerge from the interpretation of BI data that something requires further investigation and analysis. This notion is also captured in the interviews where the IT Finance Business Analyst reported that, "… we really think that 90% of our BI use is to explain deviations; explain something which looks odd". However, the BI data themselves do not guarantee the identification of distinctions since this occurs in the mind of the analyst. In our case, the BI system user is only partially aware of the elements that contribute during interpretation: the meaning of the data is their focal target. The following quote from a Regional Manager (2010) illustrates this: *"… it's a little bit difficult to discuss all this because I think it's the first time someone has asked us such questions and in a way it's a very good experience because now, suddenly, we're thinking a little bit more why we're looking at all the figures …"* Almost all the interviewees agreed that supplementing the data with personal knowledge is key. Personal knowledge incorporates previous experience and expertise, common sense and contextual knowledge. The following is representative: *"If we look into the figures, we see – well – there's something here … I'll use my experience."* (Head of IT Credit Processes, 2010). Up to this point the articulation process takes place between the BI system and the user's personal knowledge, thereby giving voice to new distinctions. These new distinctions are framed by the interplay between the BI system and the user's personal knowledge.

5.1.2 Articulation of different perspectives

The BI analysis indicated that the local market conditions story did not hold. In the same branch, there were advisors that gave discounts, while others did not. The new distinctions that emerged in the mind of an employee are followed by an investigation as to why this distinction is the case. As a result, discussions then commenced between the branch managers; advisors; performance analysts, and top management: *"Showing the results to the advisors created a common awareness of the problems and issues the branch and individual advisers have. This awareness about pricing has created room to talk about it and has helped … the advisors to talk about their difficulties."* (Branch Performance Analyst, 2012). Thus, the issue was discussed, based on the data extracted from the BI system, at different organizational levels, with a more holistic perspective being taken as a result: *"Some advisors told me that it was very difficult to get new customers if they couldn't give a discount, [but] then we discussed about giving 10% discount instead of 50% … it worked for them."* (Branch Manager, 2010). However, users reported that the BI data were not always self-explanatory, capturing only part of the whole picture. As a result, there was a need to investigate the intangible elements not captured in the data.

5.1.3 Articulation of organizational actions

The fact that BI systems enable comparisons across different units, integrating data from different systems, facilitating the surfacing of common patterns, is illustrated by looking at trends over time. The comparisons facilitated knowledge sharing and learning. First, the comparisons exposed which units (branches, managers or advisors) needed to communicate and share knowledge. Second, knowledge sharing discussions could focus on specific actions that had or should have been taken,

whether on the part of an employee, department or particular business unit: *"... I try to find out what is it that's wrong in one place, what is it that's good in another … so we can learn from each other … I call them and say, 'What do you do since you're so good?' And 'what's the problem, 'cos you're in the red?'"* (Business Analyst, 2010). However, strategic goals appear to play as significant a role in how much the BI system actually impacts or facilitates organizational action. Although observations are made and documented with the help of the BI system in instances when a particular observation concerns a topic or issue that is not seen as being particularly relevant or high priority, then actions are not taken: *"They can't stay focused on it because they change the measures all the time. This year, we have to raise our volume by 10%; next year, we should earn more money by raising our bottom line by 5%. So, their performance on price leakage returns to previous levels because of new directions that come every year... You have to have meetings once in three months to keep them on track otherwise their performance decreases."* (Branch Performance Director, 2012).

5.1.4 Data on demand

Our analysis has shown that articulation of new distinctions, different perspectives and organizational actions were associated with differences both in the amount and aggregation of data selected from the BI system. Data selection is a filtering process where one collects and integrates specific data fields, dimensions and measures in order to investigate a phenomenon or to measure different indicators. The data selection process had two main themes: data on demand, and turning data into evidence. From a BI system perspective, a 'drill down' of the data is performed where very specific variables are identified for the problem in question. The availability of data (data on demand) at different levels of aggregation makes it possible to address different decision makers and action takers. The 'drill down' and the 'roll up' activities that users are able to perform within the BI system provide transparency in terms of the measures and how they are calculated. Branch managers can have an overview of their branch but they can also drill down to identify where exactly their weaknesses lie. The advisors can track their performance over time and are also able to see the effect they have through data roll up. It is because of these drilling down and rolling up capabilities that knowledge sharing discussions can focus on specifics: *"And then we have a discussion on how come the advisor created a wrong profile. So, I think it's pretty good that we can go all the way down and drop it down; drop it down and talk to the advisors about it."* (Branch Manager, 2012).

5.1.5 Turning data into evidence

The role of the BI system, the power of data analysis in the dialogue, and the negotiations that take place, vary considerably depending on the assumptions underlying the analysis and on participant views. The more data made available or analysis undertaken at different levels that leads to the same result, the more trustworthy the BI data and the analysis become. For example, the presentation that was given to top management; the regional and branch managers, and the advisors included several – 17 in fact – charts[ii] that presented the argument at different levels and with different measures: *"When I showed the first slide they said, 'Well, where did you get that from?' And, 'All the figures in our system are wrong', and so on. And then I had ten observations, and, as you can see, they all show the same."* (Branch Performance Director, 2012). The availability of data over periods of time contributes to the accuracy of the analysis, which in turn contributes to its persuasive power. In order to create a consensus based on the data, time plays an important role, along with its perceived quality: *"…you have to see figures over a very long period. If one of our best branch managers has very bad figures, we'll look at why … but if you, year after year, have bad figures compared with ... similar branches [then you're sure something's wrong] … it's important [to have] those figures, not in the short run but in the long run."* (Business Analyst, 2010). However, issues such as data quality in BI implementations still inhibit organizations in getting the most out of BI initiatives. For example, the Head of Strategic Business Unit (2011) reported: *"We simply can't reconcile numbers across some systems where we have to figure out which one is right and which one isn't … We've also had a couple of instances [where] it turned out that that the numbers in the [BI analysis] were wrong because we were double counting; or we were comparing with numbers that were called the same so we thought we could compare them. But when we dug into it, it was two very different things; so we had to say*

'okay then forget about it, we can't do this'." These issues continue to operate as limitations to the potential beneficial effects of BI in organizational decision-making, and need to be taken into account in our conceptualisation of the role of BI systems in organizational knowing, to which we now turn.

6 Discussion

We argue that two main concepts emerge from the case study, as illustrated in Figure 2: data selection and articulation. BI systems make it possible for individuals to *articulate* hypotheses that might arise from intuition or previous beliefs and experiences, based on a *selection* of data that may not have been available previously. Due to the integration of data across different business domains, cross-network analysis may reveal previously unknown patterns, providing that like is being compared to like. However, apart from the role of BI systems in revealing new insights, the BI data themselves play an important role in transforming these insights into organizational knowledge – knowing – that can then be utilized in taking action. To make sense of these previously unknown patterns, individuals engage in dialogue with others in the organization, and with the system itself. As Polanyi (1966; 62) states, "A mental effort has a heuristic effect: it tends to incorporate any available elements of the situation which are helpful for its purpose". However, Polanyi also argues that people are only partially aware of these elements while their focus is on the act itself. While this is true for the analysts performing an analysis using the BI system, the difference lies in the fact that the available elements (the data) that the analysts are considering are not only available to themselves, but to other stakeholders in addition. BI analyses thus stimulate dialogue, leading to problem articulation from different angles and perspectives – the dialogical exchanges and the perspective taking of which Boland and Tenkasi (1995) and Tsoukas (2009) speak. When productive, dialogue leads to 'self-distanciation': to individuals distancing themselves from their customary, perhaps less reflexive, ways. Boland and Tenkasi (1995; 357) argue that knowledge integration "is a problem of perspective taking" – the process through which "distinctive individual knowledge is exchanged, evaluated, and integrated with that of others in the organization". Our data suggest that BI systems can be q catalyst that stimulates just such a dialogical exchange. Further, this problem articulation can lead to a shared understanding at the organizational level. As Brown (1981) observes, effective communicating requires that the point of view of the 'other' be realistically imagined. Others, such as Rommetveit (1980; 126), concur: "An essential component of communicative competence in a pluralistic social world ... is our capacity to adopt the perspectives of different others". The capability of BI systems to enable people to drill down and roll up data, enables them to track the data at each step, thereby facilitating discussion about the assumptions underpinning the analysis, which leads to better understanding of other perspectives.

It appears that the knowing process that is mediated by BI systems includes the appropriate "format that knowledge needs to take in order to be acceptable to others, the language or symbol system within which it must operate, and the evidence that knowledge workers must provide to support their new knowledge claims" (Schultze, 2000; 7). Thus, BI systems contribute to the balancing of subjectivity and objectivity discussed by Schultze, where subjective insights and tacit knowledge are articulated in a way that, with the backing of BI data, become acceptable and appreciable. This is so because of BI systems' capability to provide data at different levels of analysis, enabling comparisons and cross analyses, thereby fostering dialogue, and surfacing new distinctions and insights. Thus, it seems that the combination of BI analysis undertaken at several levels (which includes longitudinal data, and is transparent to all concerned), grants to BI data persuasive power and legitimizes its use in discussions and negotiations in the knowing process.

Individual and collective use of BI systems facilitates expressions of feeling and appeals to others. What BI systems add is their capability to integrate data across different domains (levels), systems and organizations. They alert people to "the tensions in activity systems", and trigger "a process of dialogue, experimentation and collective learning ... that may transform participants' understandings of their activities and the systems through which they are enacted" (Blackler, 1995; 1041). The cyclical nature of the 'data selection' and 'articulation' (cf. Figure 2), which takes place during the use of BI systems, manifests itself at an individual and an organizational level. Individuals using a BI system or analysis (the product of the system) 'take' sense from the data – meaning, in other words.

This meaning that emerges from the interaction of the individual with the BI analysis, and originates from the data through processes of selection and articulation. At an organizational level, BI systems facilitate an interpretive process in which actors influence each other through data-driven discussions. Such discussions can lead to the process of perspective making (Boland & Tenkasi, 1995), where the individual investigates and confirms the new meaning that emerges from the data via a more in-depth consideration of the analysis. This new meaning is transformed into a narrative in the person's community, thereby consolidating organizational knowing.

The new knowledge that resides in the community (knowing) strengthens and reinforces the perspective making. When this new knowledge concerns another community, it triggers the process of perspective taking in that community. Through this iterative process, each type of expertise present can take its perspective and assist other actors with different expertise to more easily recognize and accept the different ways of knowing of others. Thus, BI systems can be used in the perspective taking process to facilitate the utilization of distinct knowledge through dialogical exchanges, at different levels of analysis, through data selection and articulation. BI data, as artefacts, may thereby be used as a starting point for a collective process of discussing and negotiating articulated beliefs and practices.

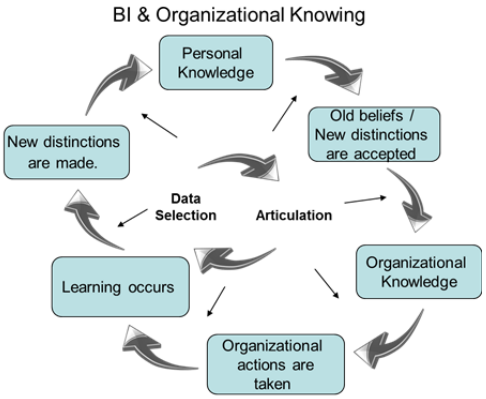

Figure 2: The role of BI systems in organizational knowing

This is not to say that there are no limitations to what analysts and users of BI systems can do. The interviews show that there are serious issues involved, both with the implementation of BI systems and their use. The poor quality of BI data is another issue – one which leads to a decrease in BI systems use, and which in turn impacts organizational knowing. High data quality – *perceived* high quality data – is a prerequisite for BI systems to have their intended effects on organizational knowing. Further, as reported during the follow-up interviews, there is considerably less benefit to be had from BI systems and analyses when management focuses on any topic not associated with the analysis. That is, even if employees gain new insights from analysing BI data, they do not necessarily act upon these new insights if their superiors are focusing on other organizational issues. Two years on from the initial interviews, the focus had shifted to other organizational goals (e.g., from pricing to credit and later to customer satisfaction), with the result that branch managers were reluctant to act on knowledge acquired two years earlier with the same persistence (e.g., the pricing curve is reverting to the shape it displayed before the pricing focus).

In summary, we have investigated how BI systems facilitate the process of knowing in a particular organizational setting. We believe the contribution to be threefold. First, we have illustrated the evolution of IS that have been designed to support organizational decision-making from the MIS era to the current day. In so doing, we have been able to distinguish between the different technologies in use over time, and have shown how BI systems have added qualities that help to facilitate organizational knowing. Second, we have developed a conceptual framework of the organizational knowing process, based on the extant literature, and used this a sense-making device in this case study. Third, and what we see as the main contribution, we have highlighted the cyclical nature of the 'data selection' and 'articulation' processes in organizational knowing, as facilitated by BI systems.

There are a number of limitations to this study. First, we have not accounted for power considerations and how they might affect the use of BI data. Further study, based on, e.g., Pfeffer (1981) and Langley (1989), would be useful. A second limitation is the single case study method. We cannot conclude that this organization is representative of how BI systems are used in all organizations. The conclusion is a more limited and modest knowledge claim. The way BI is described to mediate organizational knowing through the cyclical processes of data selection and articulation is a step on the way to understanding how BI systems may improve organizational knowing. Further studies, utilizing the model that was developed from this case, would help to test its generalizability. A third limitation relates to our interview data. Since the interviews were conducted in English, which is not the native language of the participants, there may well have been some linguistic constraints when those interviewed attempted to express themselves. While care was taken to have the interviewees check our transcripts, and we held follow-up interviews at a later stage to reassure ourselves on this score, this remains a limitation, which further case research could help obviate. Despite these limitations, we trust that these initial findings will serve as a basis for future research that can be undertaken to confirm, extend and challenge our findings.

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[i] http://www.mckinsey.com/insights/mgi/research/technology_and_innovation/big_data_the_next_frontier_for_innovation
[ii] Taken from the pricing presentation document.