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Improving Data-Driven Decision Making through Human-Centered Knowledge Sharing

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Abstract

This research focuses on human-centered knowledge sharing within data-driven decision making processes enabled by advanced analytics. The paper describes an exploratory study of an innovative approach to ongoing improvement of complex data-driven decision making processes found in a large retail distribution company by considering a complex interplay of business intelligence (BI) /business analytics, business processes and human-centered knowledge management. Using the relevant IS frameworks as analytical lens the paper investigates the evolving relationship between decision-support technology and decision making as well as the relationship among information, decisions and the corresponding business processes. The most important finding of this research is in identification of human-centered knowledge sharing as the key success factor for ongoing improvement of BI-enabled decision making in the case organisation, rather than complex technology. This in turn indicates the significance of various organisational factors, including carefully designed and implemented human-resource (HR) strategies to encourage knowledge sharing among decision makers using advanced analytics systems. Finally, this paper also confirms the latest industry reports that more mature analytical organisations are looking beyond technology and focusing on business-related issues as the next source of a more sustainable competitive advantage.

Keywords

Knowledge sharing, Data-driven decision-making, Business Intelligence & Analytics, Business processes

INTRODUCTION

The pressing needs for relevant data, timely insights and value-adding actions have propelled the field of Business Intelligence (BI) /Business Analytics to the top of business priority lists worldwide (Luftman and Ben-Zvi, 2010; Gartner, 2009).Yet, the gap between organisations that use analytics for competitive advantage and those that don't is now larger than ever before, and is rapidly widening (Krion at all, 2011).

From its diverse origins in data warehousing, simple reporting and various forms of codified intelligence, the BI field has evolved well beyond technology. BI is now seen as an "umbrella term that is commonly used to describe the technologies, applications and processes for gathering, storing, accessing and analysing data to help users to make better decisions" (Wixom and Watson, 2010, pg.14).

With BI applications becoming more mature across different industry sectors, new trends are starting to emerge with regards to BI applications and their organisational use. For example, when it comes to BI technology evolution, as defined by Eckerson (2004), many organizations have long passed the first two stages of reporting and simple data analysis (OLAP). They are increasingly reaching higher stages of evolution, exemplified by advanced analytical applications, such as predictive analytics (LaValle et al, 2011; Krion et al., 2011). "Knowing what happened and why it happened are not longer adequate. Organisations need to know what is happening now, what is likely to happen next and what actions should be taken to get the optimal results" (LaValle et al., 2011, pp. 22).

Higher levels of maturity are also reflected in a more recent terminology adopted by industry practitioners and academics alike, who increasingly associate the term "BI" with reporting and OLAP tools, while the term "business analytics" is used for more complex analytical tools. Following Wixom and Watson (2010), in this paper we adopt the term BI, as a *generic* "umbrella term" inclusive of all levels of BI maturity, thus including "business analytics".

While rapidly advancing, the latest technology developments have not altered the main purpose of BI - that is decision making support. Yet, the requirements and needs of decision makers have considerably changed. There is a new requirement to support decision-making processes at all organisational levels, especially those of front-end customer facing employees. "A goal in many companies is to make BI more pervasive; that is, to put BI in the hands of more people, and thereby ―democratize BI for the masses. This spread of BI is not only to employees but also to suppliers and customers" (Watson, 2009, p.500).

While traditional applications of BI still emphasise the link between information and BI-enabled decisions, the latest organisational applications of BI (especially advanced analytics) call for a better understanding of value-creating relationships among information, decisions and their corresponding business processes. "If you really want to put analytics to work in an enterprise, you need to make them an integral part of everyday business decisions and business processes – the methods by which work gets done and value gets created" (Davenport et. al. 2010, pg. 121). By combining information, decisions and processes, it is possible to provide a broader context for decision making and in this way, better understand its ongoing improvement by looking at the impact it has on the corresponding BPs.

The problem of BI and BPs integration is currently considered by both the BI community in the context of Operational BI (Imhoff, 2006; Indart, 2006) as well as by Business Process Management (BPM) community in the context of Business Process Intelligence (zur Muhlen and Shapiro, 2010). However, the perspectives taken are very different from the business perspective taken by this research. Here we focus on BI-enabled decision making, aiming to investigate its improvement by considering a possible interplay of information, BI-enabled decisions and their corresponding BPs.

This research focuses on a complex case of data-driven decision making enabled by advanced analytics, here termed *BI-enabled decision making,* aiming to investigate its ongoing improvement. More precisely, this research aims to address the following research question:

How do organisations improve BI-enabled decision making over time?

The paper describes an interesting case of decision-making found in a large international retail distribution company, within one of its core operational BPs. The chosen BI-enabled decision making process is examined through the analytical lens obtained by combining two existing theoretical frameworks, previously designed to describe (i) the evolving relationship between human work and IT (El-Sawy, 2003), and (ii) the relationships between information and decisions found in different types of information environment (Davenport, 2010).

The paper offers an interesting finding that the key success factor for the ongoing improvement of BI-enabled decision making in the case organisation was not in advanced BI technology, but in human-centered knowledge sharing i.e. knowledge management (KM). In addition to opening up new challenges for BI governance, this finding also confirms the latest industry reports that after achieving technical maturity, BI organisations start to focus on the business side of BI in order to create a more sustainable competitive advantage, as described by (LaValle, et.al., 2011) and (Kiron et all, 2011).

The paper is structured as follows. The next section introduces two theoretical frameworks used to provide the analytical lenses for this work. This is followed by a brief description of the case organisation and its mature BI environment. The paper then proceeds to describe the research method and the main research findings. The subsequent section describes the key lessons learned in this project, relating them to the stated research questions. To illustrate their significance, these lessons are placed in the context of the relevant literature from BI, knowledge management (KM) and business process management (BPM). This is followed by the discussion of research limitations, conclusions and future work.

THEORETICAL FRAMEWORKS AND RELATED WORK

This section offers an overview of two frameworks and describes their relevance for this research. The first framework by El Sawy (2003) offers three evolving views of IS described through different levels of integration of IT and human work. The second one by (Davenport, 2010) describes possible types of relationships between information and decisions.

The Connection, Immersion and Fusion views of IS

The framework describing the *Connection*, *Immersion* and *Fusion* views of IS was designed by El Sawy (2003) to capture the evolving nature of IS in organisations and their impact on, and, integration with human work, as depicted by Figure 1. The three views are briefly described as follows:

- *Connection View of IS:* In this view of IS, IT is perceived as an important but *separable artefact* from people and their work. In other words, while IT does provide valuable support, if required, it can be pushed aside and the work will still continue. Examples include a simple report, a spreadsheet application, a database query – all designed to inform human work that could continue even without such a support.

- *Immersion View of IS:* This view started to emerge in 1990s with early applications of various types of complex enterprise integration systems, such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and supply-chain management systems. This view sees people working in an IT-intensive environment where work and IT-processes are so intertwined, that IT cannot be pushed aside for human work to continue. People are connected to the business environment via IT so much that to operate effectively they need to change the way they work as individuals, groups, enterprise or even across enterprises. This often means that business processes need to be changed too, in order to take the full advantage of IT.

Figure 1 The Connection, Immersion and Fusion views of IS (El Sawy, 2003)

- *Fusion View of IS:* In this view IT is not only immersed, but it is fully fused with the business environment. This means that any attempt to break it down will only result into IT-enabled work of a finer granularity. When this model was originally proposed by El Sawy (2003) the fusion view was predicted to appear after 2004, as shown by Figure 1. Some applications, such as those personalised knowledge portals or advanced analytics, do indicate that the Fusion view is emerging.

Relationships between information and decisions

The second theoretical framework used in this research was previously introduced by Davenport (2010), based on a very comprehensive study of various types of complex decisions in 26 organisations. The study focused on possible relationships between information and decisions, especially in BI-supported information environments. The main objective of Davenport's study was to investigate how organisations ensure that decisions are made on the basis of the best possible information and that the right information is gathered and analysed to support decision processes. The study resulted in a theoretical framework that identifies three different types of information environments, each characterised by a different type of relationship between information and decisions:

- *Loosely-coupled information environments:* In these environments, the required information is made broadly accessible to analysts and decision makers, along with the tools to analyse it. As this information is intended to inform a wide range of possible decisions, its use is based on an individual decision maker's initiative and as such, it is not predetermined by any procedures or models. To make these environments more effective, Davenport argues that new approaches are required to provide much more than simply make information available. But at the same time, more structure or automation may not be appropriate or necessary, as all decision-making alternatives are impossible to predict in advance.

- *Structured human-decision environments:* In these environments decisions are made by human decision-makers (i.e. they are not fully automated), but "specific efforts have been made to improve decision-making processes or contexts by determining the specific information and other process resources needed to make better decisions faster" (Davenport, 2010, pg. 7). Compared to the loosely coupled ones, these environments have a narrow focus on a particular decision. They are designed to support decision-making by, for example providing additional structure or necessary tools around very specific decision processes. This approach is not suitable for all types of decisions and should focus only on those that are critical, due to the cost and complexity involved.

- *Automated decision environments*: These environments include decision rules and algorithms embedded in the automated business processes. Decision-making is delegated to the rule-engines while humans take care of exception handling. The main objective here is to make the process fully automated and therefore very efficient. This is suitable for decisions that are well structured and easily reduced to a set of rules. This also means that all information needs are determined in advance so that each decision could be easily automated.

Davenport argues that the above three environments should be used to guide any organisational implementation of BI applications. Thus, in order to select the right tools for a particular type of environment, it is necessary to focus on critical decisions that need to be made, but also to fully understand the relationship between these decisions and information required.

Relevance of chosen theoretical frameworks for our research

As previously stated, this research aims to address the following research question:

How do organisations improve BI-enabled decision making over time?

In this context we consider the following related and more detailed sub-questions:

RQ1: What are the key perceived challenges and critical susses factors?

RQ2: What is the relationship between BI-enabled decisions and business processes within which they exists? How does this relationship impact on the ongoing improvement of decision making?

RQ3: How do organisations monitor and measure the improvements in decision-making?

RQ4: How is BI technology integrated with human knowledge work?

Using the Connection, Immersion and Fusion Views of IS as the first analytical lens this research aims to explore the evolution of BI-enabled decisions and the role of BI technology in this context. More precisely, we focus on a specific aspect of human work (i.e., complex data-driven decision-making), and a particular type of IT (i.e., BI) and use the three views of IS to analyse their evolving relationships, in order to better understand the ongoing improvement of BI-enabled decision making as well as the nature of BI technology integration with human work. Thus, the first framework is expected to help us to get some important insights related to research questions RQ1, RQ2 and RQ4.

Building upon Davenport's framework for linking decision and information, this paper goes one step further aiming to link processes and BI-decisions made in the context of these processes. This is expected to lead to a better understanding, not only of the challenges and critical success factors of BI-enabled decision making (RQ1), but also of different approaches used to monitor and measure potential decision-making improvements (RQ3).

CASE ORGANISATION

The case organisation chosen for this research is a large international wholesale retail distribution company, here named AP-Distributers (APD), operating in the Asia/Pacific region for many years. This is a very mature BI organisation, with a very complex BI environment that has gradually evolved over the last 15 years. Their first installation of a BI system included the *Sales analysis* and *Promotional effectiveness* applications. Following the success of these early applications, APD's BI environment continued to evolve and "climb" the maturity curve towards more advanced stages. Very recent examples of advanced BI applications include: *Retail analytics* used to help retailers to drive increased sales of "hot" products, and *Promotional analysis* used to drive future promotional programs.

This very complex BI environment currently provides a consolidated view of the whole business and supports a community of more than 500 internal users and over 2000 retails. Owing to its advanced BI practices, APD has been acknowledged by industry peers as one of the industry leaders in the local region and beyond. In a very recent industry report, the company identified the following key benefits of its BI environment:

- Ability to measure the effectiveness of promotional campaigns by tracking against sales activity
- Ability to flag potential problems, such as delays, before they create a bottleneck in the supply chain
- Ability to monitor buyer behaviour and respond with the best product mix
- Ability to predict future demand, based on historical trends, and use it for accurate manufacturing forecasts

Furthermore, APD's BI environment is also fully integrated along the whole value chain, supporting the company's key operations. For example, BI enables the company to regularly review its production plans for the following six to twelve months. This is critical for the manufacturing of store generic brands with long lead times, because running out of stock for long periods of time creates a significant impact on their retailers. At the retail level, BI is helping stores to range the right products based on consumer demand, allowing the APD's decision-makers to intervene early in case of any unanticipated problems.

The company also has an Operational BI strategy in place to maximise warehouse efficiencies and benchmark its Distribution Centres to achieve and measure best practice. This *particular benchmarking* aspect provides a context for this research, as described later in the paper.

APD's core BPs are supported by an equally complex business process management (BPM) environment, consisting of several fully integrated regional ERP systems. Very large volume of data generated by those ERP systems as well as other operational applications are consolidated and fed into APD's enterprise-wide data warehouse. This in turn provides a "single version of truth" enabling quite detailed enterprise-wide business analysis. For example, this complex environment enables APD to run more than 5000 reports per week, along with quite complex analytical applications such as *Retail analytics* and *Promotional analysis.*

Furthermore, through their integrated process and analytical environment, this organisation has already achieved a very high level of efficiency of their core intra- and inter-organisational BPs. The company has also achieved a high level of technical integration between their BI and BPM (ERP) systems.

In summary, based on the fact that BI is used for their key operational decisions as well as to inform the organisational strategy, it is possible to classify this company as "Transformed" in terms of LaValle et al's (2011) classification of analytical organisations. In terms of BI tools' evolution Eckerson's (2004), APD demonstrates the characteristics of level 5 organisation, due to its use of advanced analytics. ADP's analytical maturity was the main reason why this company was chosen for this research.

RESEARCH METHOD

In line with the exploratory nature of this research, a case study method that involved an interpretive approach was adopted as the most appropriate to capture and understand the contextual richness and complexity (Yin, 2003). Interpretive research offers an opportunity to understand the phenomena through the meanings that people assign to them (Deetz, 1996). Given the researcher's expertise in BI as well as BI-enabled BPs, she was in a position to understand the findings not only from the research but also from the industry perspective, creating an opportunity for more in-depth semi-structured interviews with the practitioners.

After the most suitable case organisation had been identified and access granted, the researcher adopted the following research method. To establish a shared context necessary for knowledge sharing, the first step involved a short presentation, given to a multidisciplinary audience, comprising of company employees representing different perspectives (IT and Business, BI and ERP/BPM). The main objective of this presentation was to give a brief overview of the research context in order to establish a shared understanding of the key concepts and avoid possible misunderstanding that could easily occur among domain experts from different disciplines (e.g. BI and BPM). For example, even the basic terms such as BI, BP or even decision-support could be easily interpreted quite differently. The presentation was followed by a round-table discussion with the main objective to identify the potential candidate examples of complex BI-enabled decisions and their corresponding processes. After considering set of processes, the researcher then selected one process for this particular study, due to its complex decisions supported by advanced BI analytics. The identification the initial pool of candidate processes had to involve the practitioners, due to their contextual knowledge, while the final selection was made by the researcher without practitioners input or influence.

Data collected in this initial session was then used to refine the exploratory questions and prepare for the next stage of research, giving enough time for reflection between different stages of data collection. Following the principles of case study research (Yin, 2003), the next stage involved semi-structured interviews focusing on a particular type of complex decisions identified and selected during the initial group discussion. The special emphasis was placed on the chosen example of BI-enabled decision-making, its ongoing improvement, its corresponding business process and the level of technology integration with human work.

Like all interpretive studies, this study sought a subjective understanding of the conditions, practices and consequences of social action as expressed by the stakeholders in their particular social context and are expected to reveal complexities and details that are commonly omitted in quantitative studies (Mason, 2002). However, to ensure that the interpretation made was correct for the given context, the researcher sought a feedback and, when required, additional information to corroborate data sources and the actual data collected. The researcher's domain expertise was very helpful in this process, due to her ability to comprehend the working of complex organisational system from the technical and business perspectives.

RESEARCH FINDINGS

This research focuses on the complex analytically enabled decisions found within APD's core business process called *Planning, Forecasting & Replenishment* process. As its name suggests, this process consists of three main activities (tasks): planning, forecasting and replenishment - all involving complex decision-making supported by advanced analytics.

Using the previously described analytical frameworks, the researcher analysed this decision making environment, looking at the relationships between information, decisions and processes, as per Davenport's (2010) framework, while considering the level of integration between work (i.e. decision-making) and IT (i.e. BI environment), guided by El Sawy's (2003) framework. This analysis revealed a very innovative approach to the ongoing improvement of their BI-enabled decision-making, as described below.

The "Structured human-decision" environment at APD

The Planning, Forecasting and Replenishment process is an ongoing BP, performed at each distribution centre. The key decision maker in each distribution centre was identified to be its stock controller. His/her decision-making process was supported by a complex analytical BI environment that could be best classified as a "*structured human-decision*" environment. As per Davenport's framework (2010), this environment was designed to support decision making by providing specific information and other process resources in order to help a decision maker to make better decision faster.

It is important to recall that in the structured-human decision environment, all critical decisions are made by human experts rather than fully automated. This was the case with ADP. Each stock controller was supported by his/her structured human-decision environment in a form of a role-based portal designed to provide relevant, timely and contextual information, necessary to support their decision making process. For example, stock controllers used BI-generated reports, providing an accurate and up-to-date insight into all key parameters (e.g. "what is currently in stock", "what is in demand", "what is the lead time in order to get new stock from vendors", "what is not selling" etc.).

The BI system also offered a rule-based engine designed to support the replenishment activity in each region. The rules were used to store the explicit knowledge related to the replenishment activity, such as current stock levels, orders, lead-time etc. However, this environment could be classified as structured-human, rather than an automated decision environment, because the more complex decisions were always made by humans, rather than a rule-based engine. This was because these decisions require the experiential knowledge of each stock controller, found to be critical in terms of organisational agility and responsiveness to dynamic market conditions, especially customers' demands and preferences.

Some of this experience could be externalised and captured by the rules but only for the well-structured, repetitive cases. At the same time, more important tacit knowledge, held by the decision makers, could not be captured. The KM field already provides strong evidence that trying to capture and model all aspects of expert's tacit knowledge used for complex decision-making will never be possible in entirety (Malhotra, 2004).

Consequently, the key value-add aspect of the overall *Planning, Forecasting & Replenishment* BP was found in these experiential decisions i.e. in the ability of decision makers to make good but fast decisions, based on timely and relevant information, supplied by the BI system. Once these decisions were made, their execution was then supported by automated workflows. The same BI system was also used to "close the loop" i.e. monitor and measure the effectiveness of these key decisions by measuring the effectiveness of the corresponding BPs.

Looking from the perspective of our second analytical framework by El Sawy (2003), we argue that the above described "structured human information environment" adheres to the *Immersion view* of IS. As such, even though quite complex, this environment does not significantly differ from other advanced analytical environments found in the retail industry today.

An innovative approach to ongoing improvement of BI-enabled decision making at APD

Having reached a high level of analytical maturity and with other retail competitors gradually achieving the same capability, the APD company started looking for more sustainable sources of competitive advantages. Like many other organisations, they focused on their core processes and identified the above-described *Planning, Forecasting & Replenishment* process as their key differentiator.

In this context, they started to investigate possible improvements of this critical BP. BP improvement was initiated by the enterprise BI manager who, in addition to BI expertise, also had prior experience and expertise in BP improvement.

When analysed from the process perspective, this particular process turned out to have a very simple high-level model, consisting of three tasks. Furthermore, owing to the complex, knowledge-intensive nature of these tasks, any attempt to model all possible decisions was not considered as appropriate, even if possible to some extent, due to the experiential knowledge involved. Consequently, they could not use the mainstream methodologies for BP improvement based on process models (e.g. control flows, order and timing of individual tasks) and the so-called BP lifecycle.

Bypassing the modelling, they turned their attention to the key value-add within this process. Consequently, they focused on the BI-enabled decisions, in particular the experiential knowledge of the stock controller in charge of these decisions.

Most importantly, same BI system that was already used to benchmark the distribution centres, also identified the top performers i.e. the best performing decision maker(s), across the complete network, through their corresponding distribution centres. This was possible and did not require any additional analytical effort, because each distribution centre had only one key decision maker.

Zooming in on their key decision makers and their advanced analytical environment, this organisation started to look for possible ways to improve their decision-making capabilities. Having in mind the fact that that they were already measuring the performance of the overall process, any such improvement could be detected by the existing analytical applications.

In addition to improving their human-structured environment, by providing more and better IT capabilities (e.g. personalisation, better visualisation), this organisation decided to focus on a much more challenging ingredient – i.e. the experiential knowledge of its key decision makers. More precisely, rather than trying to externalise and reuse their experiential knowledge in a codified forms, the main idea was to use the same BI system to identify top performers and then enable/encourage them to share their knowledge/insights/practices with the other stock controllers, across company's distribution network via newly formed Communities of Practice (CoP). To encourage and reward knowledge-sharing practices, the next step was to design HR-based initiatives, such as bonus payment for mentoring other staff members. To further support knowledge sharing they also developed and introduced a wiki-based knowledge-sharing platform.

After more than a year of using this approach to ongoing improvement of BI-supported decision making through knowledge sharing among key decision makers, the initial results were reported as encouraging. Most importantly, all interviewees shared the same expectation that, over time, these human-centered knowledge-sharing activities would improve the performance of these key decision makers across the whole enterprise. Further research is required to confirm their expectation.

But at the same time, decision makers did not perceive the wiki-based solution as critical for their knowledge sharing. Rather, they pointed out that in this organisational environment, so far, human-based knowledge sharing through conversations and exchange of ideas ("*we just pick up the phone and talk to people*") was much more effective than sharing via wiki-based platform. However, as members of this community are getting to know each other, some of them did start to share their insights via wiki-based knowledge sharing platform. "*We prefer to meet and talk first, so you know the person behind each comment*" *<a CoP member>*.

This company is currently considering different ways of making knowledge sharing activities an integral component of people's work, thus making the ongoing improvement intertwined with the BP itself. But, so far, and looking from the perspective of the Connection, Immersion and Fusion view of IS, the wiki-based solution appears to fit the *Connection view*. By trying to better integrate the wiki-based knowledge-sharing practices with their work, the organisation is aspiring for the yet-to-be achieved Immersion view.

In spite of the BI system being the key enabler of this innovative approach to BP Improvement, this organisation recognises that its key success factor is not related to technology, but to human-centered knowledge sharing. Consequently, they perceive the HR (Human Resource) strategies designed to encourage and reward knowledge sharing to be of critical importance for their performance improvement, as described here.

Most importantly, these company-specific HR strategies when combined with the experiential knowledge held by human decision makers, in the supportive organisational culture of knowledge-sharing and non-competitive decision-making, make the resulting combination very hard to replicate and acquire by APD's competitors. The organisation expects it to lead to a much more sustainable competitive advantage than BI technology alone.

DISCUSSION AND LESSONS LEARNED

This section summarises some key lessons learned about BI-enabled decision-making and its ongoing improvement found in the context of the case organisation and places them in the context of the related literature. These lessons are envisaged to be relevant not only for the BI, KM and BPM researchers and practitioners alike, but also for those interesting in possible ways of integrating these independent, yet highly related fields.

- The key success factor for ongoing improvement of BI-enabled decision-making, as described in this paper, lies beyond technology. (RQ1)

As already stated, the key success factor, as reported by the interviewees, was found to be in human-centered knowledge sharing. This also created the need for the HR policies to be redesigned to encourage and reward knowledge-sharing, that in turn enabled the ongoing co-evolution of BI technology and human practices. The related research from KM (Malhotra, 2004) and knowledge-intensive processes (Davenport, 2005) confirm that unless these practices become a fully integrated, even ubiquitous part of everyday's work, they are very likely to fail. This also has some important consequences for the design and implementation of knowledge-sharing technology (in this case a wiki-based solution), not only in terms of content, but approaches to technology diffusion and adoption.

- Improvement of BI-enabled decision making is achieved through human-centered knowledge sharing. (RQ2)

When observed from the process perspective, BI-enabled decision making and knowledge sharing create an *human-centred information* environment for what appears to be a new type of "closed-loop" self-regulating BPs, where improvements come from the "grass roots" and their everyday work. Therefore, it is in the context of these processes, that IT and this new way of working become so intertwined, as depicted by Figure 2, thus showing the characteristics of the *Fusion view* of IS. Without BI support it would not be possible to identify the best performing decision makers that in turn fuelled the need for human-centered knowledge sharing among them, as described in the case. Even more, rather than focusing on the information needs of an individual decision-maker, as originally envisaged by Davenport (2010), this environment is likely to become "human-structured enterprise environment" that remains BI-enabled, but human-driven.

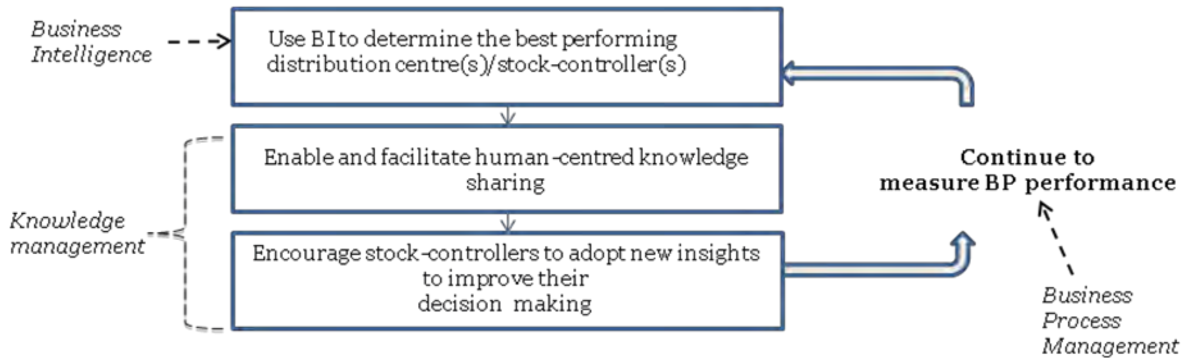

Figure 2 Improvement of BI-supported decision making

- BI-enabled decision improvement requires new approaches to performance management of processes and people involved. (RQ3)

The current BI system offers the necessary quantitative data to measure the efficiency of the core *Planning, Forecasting and Replenishment* process, as well as individual performances of stock controllers, but in their "old" roles of individual decision makers. In fact, this particular aspect of BI-enabled performance management, has led to the innovative approach to BI-enabled improvement of decision-making, in the first instance.

However, the BI technology is found to be *transformational* as it is changing the role of stock controllers from individual decision makers to knowledge workers, members and potentially leaders of CoPs – all well beyond their immediate work context. The ongoing performance assessment of knowledge workers is a much more complex problem (Davenport, 2005), especially in a collaborative environment.

This is also an interesting challenge from the BI perspective, as it creates the need to derive and analyse "employee-related" intelligence from different sources of quantitative as well as qualitative data. Discovery, validation and use of relevant *qualitative sources* of data, in other to perform the required analysis are even more challenging in the BI field that is still predominantly focused on quantitative data analysis. This particular observation illustrates the need for an integrative analysis of qualitative (contextual) and quantitative data, that has been recently confirmed as a very important future direction in BI, see (Martin, 2010).

- The relationship between technology and its use in the Connection, Immersion and Fusion View of IS does not follow a liner progression from less to more integration. (RQ4)

Finally, this case illustrates that the process of immersion of IT into human work, as described by the Connection, Immersion and Fusion Views of IS (El Sawy, 2003), does not need to be progressive, with IT getting more and more integrated. In fact, the same technology, in this case, a BI system, could be used in all three ways, within the same organisation, at the same time, but for different purposes.

For example, depending on the level of its organisational adoption, the same BI tool, could be used in the Connection but also in the Immersion views (e.g. providing relevant information, deemed critical for decision making purposes). The same BI system could be also placed within the context of Immersion view, as demonstrated by the example of ERPs and BI integration in the case organisation. Even more, different IT systems co-existing within the same environment (even the same functional group), could adhere to different views. This was the case of the emerging wiki-based solution that could be seen as an example of the Connection view of IS, because the knowledge-sharing practices do go on and could continue without this system.

This particular lesson learned fully supports the key issue for IS theory development in the Fusion view, as identified by El Sawy. More precisely, using the principles of the so-called holonomic theory, firstly proposed by Bohm (1980), El Sawy states that "The laws of the whole are embedded in the implicate domain, rather than in the explicate domain. It is almost like saying that the secret to understanding the behaviour and form of Swiss cheese in the holes, rather than the cheese. And the holes exist in a different domain than the cheese – and this domain has different rules and representations" (El Sawy, 2003 pp. 586).

The same metaphor is highly applicable to this research project. Thus, the key to understanding of the ongoing improvement of BI-enabled decision-making (i.e. the *explicate* domain of our research or "metaphorical cheese")", lies in the issues surrounding the technical solutions (i.e. its *implicate* domain or "metaphorical cheese holes"). In this case, these issues are related to organisational capacity to design and implement strategies that encourage, support and adequately award human-knowledge sharing. Therefore, new practices need to be designed, introduced and carefully evaluated to encourage grassroots leadership and innovation by knowledge workers, in this case, BI-supported decision makers.

CONCLUSIONS

The main objective of this research was to investigate an innovative case of BI-enabled decision-making and its ongoing improvement, found in a large retail distribution company. Using the existing frameworks by El Sawy (2004) and Davenport (2010), the paper investigates the evolving relationship between decision-making and decision-support technology, as well as the relationship among information, decisions and the corresponding business processes. The most important finding of this research is in the reported key success factor, found to be human-centered knowledge-sharing, rather than very advanced technology. The research also confirmed previous findings by (Williams and Williams, 2003) that business value of BI and therefore BI-supported decisions is best determined through its impact on the corresponding business processes.

Our research findings are made in the context of an organisation that is considered to be among analytical leaders in the retail industry in this geographical region. Therefore, one could argue that the chosen organisation is not a typical one, as organisations at the lower levels of analytical maturity are likely to have different challenges in the context of their decision making processes. This could be seen as the main limitation of this research. However, given the emerging nature of this area, such complex processes containing decisions supported by advanced analytics, could be only found in more mature analytical organisations.

Furthermore, this research provides a further confirmation for the latest industry reports, such as (LaValle, et. al, 2011), that mature analytical organisations, are now looking beyond technology and focusing on business-related issues as the next source of competitive advantage. In this case, they included APD's organisational culture that encouraged collaboration as well as HR strategies designed to reward knowledge sharing.

Finally, the level of fusion between BI and human work, as described here, has a potential to evolve even more in the future. The foundations have been set for the ongoing, "self-correcting" and self-evolving processes. This in turn creates new challenges related to process improvement, change management, leadership, organisational learning and grassroots innovations.

Our current and future research involves further investigation of the issues and opportunities created by an ongoing evolution of this "living" system found in the case organisation from the BI, BPM and KM perspectives, as well as identification and analysis of more cases of BI-enabled decision-making in other mature organisations. Additional examples have already been identified in large financial and insurance organisations using complex analytical decision making in the context of campaign management and customer services. Further studies of these processes are expected to lead to an improved understanding of BI-supported decision making, and potentially new patterns of human work, especially those enabled by the emerging visual analytics technologies.

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