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Looking Beyond Technology: A Framework for Business Intelligence and Business Process Management Integration

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Abstract

While the initiatives for BPM and BI integration are becoming more and more prominent, especially with the raise of operational BI, current integration efforts remain mostly at the technical level. This paper argues that BPM and BI integration should be investigated from a holistic perspective, rather than reduced to technical problems. The paper aims to investigate the integration problem in terms of different types of business processes, the associated types of decisions and the information needs of decision makers. It then proposes a theoretical framework that could be used as a starting point towards an evolving roadmap for BI and BPM integration. The paper also describes an exploratory case study used to confirm the proposed framework.

Keywords: Business Intelligence, Business Process Management, Process-related knowledge

1 Introduction

In very recent times, the number of organisations interested in Business Process Management (BPM) is rapidly growing, as they are increasingly looking for the new ways to remain competitive in a constantly changing business environment. From an earlier focus on cost-saving and improved efficiency, typically achieved via Business Process (BP) automation, the latest thinking in this field emphasises organisational agility. "Agility – an enterprise's ability to respond efficiently and effectively to environmental change is becoming the most important benefit of BPM, garnering even more potential for transformative improvement than BPM's ability to reduce costs and increase productivity" (Gartner, 2008a). However, for many organisations, the concept of agility is still reduced to technical agility. Even though technical agility is important,

"an appreciation of human factors is pivotal to the successful integration of agility-enabling technologies" (Gunasekaran and Yusuf, 2007).

As the concept of agility is now expanding to include human factors, it is not surprising that the focus of BPM is also expanding beyond technology. Leading organisations are now taking a holistic approach to BPM that encompasses four highly intertwined and equally important components: strategy, people, processes and process-support systems.

Human agility is achieved through knowledge work and complex, situational decision making. "Agility is more likely to emerge from a creative process of exploration and not from mechanistic, prescriptive and commoditized techniques and technologies in our thinking, in our reaction to change" (Desouza, 2007). As decision-making relies on high-quality data, the BPM community is now interested in tools and methods to turn process-related data into the so-called BP Intelligence.

Improved decision making has also been an ultimate goal of another, more established discipline – Business Intelligence (BI) for a much longer period of time. Factors such as an ever increasing number of very diverse internal and external data sources, the sheer volume of data generated and used in everyday business, complexity of business processes as well as various compliance, privacy and other data related issues, have made cross-organisational data integration and analysis more complex than ever before. These challenges have, in turn, created a renewed interest in the field of BI, including tools and applications, as well as new frameworks and technologies. For example, a very recent survey of CIOs worldwide showed "that BI applications were technology priority, so it comes as no surprise that BI investments are raising" (Gartner, 2008b).

While in the past, BI was used to describe a very broad range of applications, where the main focus was to "extract" and codify human expertise, the latest thinking in BI emphasises IT support for human intelligence, in the context of business decision making. In a nutshell, BI applications provide an integrated sources of enterprise-wide, highly summarised data (typically stored in a data warehouse/data mart), combined with tools for very sophisticated data analysis. However, long experience in using BI tools, confirms that providing tools and information to people is not sufficient to improve decisions. Information needs to be considered in its context. As decisions are made in the context of BPs, the BI community is now starting to consider BPM.

The very recent raise of *operational business intelligence* (Imhoff, 2005) has made the issue of BI and BPM integration even more prominent. However, companies are still focusing on technology, often taking an ad-hoc rather than a systematic approach.

This paper argues that it is necessary to take a holistic approach to BI and BPM integration and start to consider the non-technical aspects as they seem to be critical for determining the business value of BI and BPM tools. However, at this point of time, there are no theoretical frameworks and models designed to at least, raise an awareness of the non-technical issues, let alone guide organisations in their integration efforts.

This paper hopes to open a discussion between BPM and BI communities, by providing a better insight into the nature of BI and BPM integration beyond technology. Its main objective is to better define a problem (i.e. why and where organisations need to consider possible BPM and BI integration), especially with regards to different types of business processes, the associated types of decisions and the information needs of decision makers. It does it by posing two key research questions:

- *Why and where organisations need to consider BI and BPM integration*
- *What type of integration would be most suitable for different types of BPs.*

This paper argues that possible answers to these questions will always be contextual and cross-disciplinary, rather than within the domains of individual BI and BPM disciplines. Therefore, instead of offering a single answer, this paper proposes a theoretical framework that could be used as a starting point towards an evolving roadmap for BI and BPM integration. This framework is designed to combine two related conceptual models that come from BI and BPM fields, with an added value of providing a holistic BPM context to BI supported decision tasks. The special emphasis is placed on different aspects of BP improvement methodologies applicable to different types of BI and BPM integration. Design of this framework is based on a very extensive literature review, both scientific and trade-press, as well as prior case studies completed by the author in both BPM and BI fields. The framework is currently being used in a series of exploratory case studies designed to research decision making environments in the context of customer-facing, knowledge-intensive BPs. One of these cases is described in this paper and is used to illustrate and confirm the relationship between information, decision and business processes, as proposed by the theoretical framework.

2 Theoretical background

The section provides a brief overview of the latest thinking and developments in the fields of BPM and BI. As both fields are still emerging, it is important to establish a shared understanding of the main concepts, providing a common starting point.

2.1 2.1 Business Process Management

The need to improve customer services in terms of efficiency and effectiveness, to bring new products and services rapidly to the market, to reduce operational cost, and increase enterprise agility, have pushed BPM to the top of organisations' priority list (Gartner, 2006). "Attention to BPM is growing rapidly as people search for new ways to master their unruly BPs – to close the gap between the strategic vision and goals and the operational execution and achievement of these goals". (Gartner, 2008a).

BPM is no longer considered to be technology and has evolved from BP reengineering that was popular in early 90s. "BPM is a management practice that provides for governance of a business process environment towards the goal of improving agility and operational performance. BPM is a structured approach that employs methods, policies, metrics, management practices and software tools to manage and continuously optimize an organisation's activities and processes…These practices incorporate myriad resources: people and the organisation, the processes themselves (considered as assets) and BPM technologies, as well as the interrelationships of the processes within the context of the business and its goals." (Gartner, 2008a).

Business leaders are increasingly adopting the so-called holistic model of BPM that encompasses four intertwined components: strategy, people, BPs and technology (Harmon, 2007). While strategy defines organizational goals and objectives for value creation, the actual business value is created and delivered to customers via BPs. In

general, a BP is defined as a set of coordinated cross-functional organizational activities/tasks, guided by organizational policies and procedures towards a shared business goal. BPs are supported by BPM systems and other technologies, that typically range from simple BP automation systems, to complex systems designed to provide user-driven support for ad-hoc communication, collaboration and coordination.

Industry-wide consideration of the holistic BPM model has resulted in an increased recognition of the knowledge and experience people develop, use and share, while participating in all phases of the BP lifecycle. In response, BPM has started to evolve beyond operational BPs to include *knowledge-intensive processes*. While in the case of operational BPs their value comes from improved efficiency, it is now becoming clear that in the case of knowledge-intensive BPs, their value can be directly attributed to people's knowledge and experience required for situational decision making.

"We have knowledge workers who for the most part work on non-routine tasks and complex efforts. Emergent work practices are becoming common rather than prescribed projects. Most of the simple tasks have been automated or soon they will be" (Desouza, 2007). Obviously, knowledge workers rely on high-quality data from a wide variety of data sources, both internal and external and a system support that cannot be always pre-determined in advance. Therefore, knowledge-intensive processes will have different BI-related requirements than transactional, routine BPs at the operational level.

2.2 2.2 Business Intelligence

One could argue that BI has been around for many years because people have always dealt with data and information in order to make decisions, with or without any computer support. However, only in very recent times the nature of information and decision making have become so complex and dynamic forcing the companies to look for different BI solutions to help them to derive more intelligence from their data.

Rather than trying to capture and store human intelligence, the latest thinking in BI emphasizes IT support for *human* intelligence in the context of business decision making. In a nutshell, BI applications are used to provide *integrated* sources of *enterprise-wide*, high-quality data (typically stored in data warehouse/data marts) combined with tools for very sophisticated data analysis. The main objective is to support complex decision making by end-users who have the required domain knowledge to interpret the outcomes of data analysis.

While the initial focus was on strategic decisions, in recent times, the emerging trend of *operational BI* emphasizes decision making at all organizational levels and better integration of BI with operational business processes. The main objective is to combine real-time or "ready-time" operational data coming from operational business processes with highly integrated historical data stored in enterprise-wide data warehouse. This has resulted in BI applications moving from the »back-office« reports produced by designated knowledge workers, to the front office and customer-facing employees who are now becoming knowledge workers creating value-add processes for their customers.

The initial implementations of BI were *data-centric* where the main emphasis was on reporting and advanced analytics. While these applications are still the most widely used type of BI, operational BI introduced a need for *process-centric* applications that require better integration of BI solutions with intra- and inter- organisational BPs. This

in turn has created a pressing need for new frameworks and methods. In their absence organisations are forced to create their own approaches or are left to follow a vendor-directed journey to BPM and BI integration that may, or may not suit their information and BP-related needs.

3 Related work: BI and BPM integration

3.1 3.1 Exploring the need for BPM and BI integration

There are many reasons why both BPM and BI communities had started to consider different ways to combine their efforts, even before the emergence of operational BI. A shared interest in improved decision-making processes is certainly one of them. Furthermore, in order to manage their processes, organisations need access to high quality, enterprise-wide data, especially when dealing with exceptions and highly agile BPs. At the same time, BPs generate and use transactional data, thus providing the context for data and information interpretation along the so called "BI information value chain". Looking from the BI perspective, data generated and used by various BPM systems need to be integrated with the other data sources, in order to support enterprise-wide data analysis.

There are also other reasons that go beyond data integration issues. Both BI and BPM strategies should be aligned with organisational strategy, and as such should be mutually aligned, at least to some extent. This is a very challenging task because BPM and BI fields come from fundamentally different organisational viewpoints (data-centric and process-centric) that have been up to now considered to be incompatible.

Furthermore, decision-intensive BPs require different type of BP improvement methodology that goes well beyond the control-flow paradigm, widely used for improvement of highly structured repetitive BPs. This is very important, because companies that engage in ongoing improvement of these processes, are likely to experience more benefits from their BI applications (Watson, 2008). However, systematic methodologies for ongoing improvement of decision-intensive BPs are not available and are considered to be the next frontier of BPM (Davenport and Harris, 2007). In the absence of these methodologies, organisations are left to invent their own approaches, often investing very expensive resources in one-off solutions.

Most importantly, BPs are now considered to be the key to determining the business value of BI applications. "Business value of BI lays in its use within management processes that impact operational processes (which in turn, drive revenue or reduce costs), as well as its use within those operational processes themselves" (Williams and Williams, 2003). The following section describes current approaches to BI and BPM integration as reported in the literature.

3.2 3.2 Literature review

A very comprehensive literature review confirms that the need for better BI and BPM integration had appeared in the trade press long before it was considered by both BPM and BI research communities. Furthermore, while these communities have identified the need for better integration, views expressed are often single-sided, reflecting a disciplinary point of view, rather than being integrated and cross-disciplinary. The main objective of this section is to illustrate the current approaches to BI and BPM integration and motivate a need for a different type of integration that goes beyond technology.

Regardless of the view taken, data-centric or process-centric, according to the current scientific and trade literature, BI and BPM projects are typically integrated in two different ways, both of them technical. The first one is to implement BI solutions on the top of a BPM system. Alternatively, a BPM system is used as a source of process-related data for a BI solution.

The first type of integration enables process analysts and operational managers to get a better insight into operational processes, so they can identify process inefficiencies, as well as possibilities for improvement. This applies to individual processes as well as to a set of related processes. For example, in the case of an exception (a delay in the procurement process), an application of a BI service on the top of a BPM system, will enable the procurement manager to analyse possible causes and effects of the identified delay on different operational BPs, so they can better manage this exception.

This particular approach has been strongly promoted by researchers and practitioners in the BPM community, as they seek to extend monitoring and analytical capabilities of the existing BPM systems. For example, the Business Process Intelligence (BPI) tool suite, proposed by (Grigory et al., 2004), describes a set of integrated tools that provide several features such as analysis, prediction, monitoring and optimisation of business processes. Another notable example includes the so-called BPI techniques suite that includes a set of process mining techniques, used to discover a model of a composite web service (i.e. a business process) and its transactional behaviour from process logs (Gaaloul, 2005). Although these two examples of BPI illustrate very sophisticated analysis of business processes, this analysis is more technical than business oriented. On the other hand, in order to determine and improve the business value of BPM &BI technology it is necessary to bridge the gap between business and technology levels, and start looking at technical solutions from the business perspective.

Another serious limitation of the existing BPM solutions, also related to BI and BP integration, is that they do not support cross-platform BI analysis of different BPs, if supported by different BPM systems. However, this type of analysis is very important, because processes do not exist in isolation.

The second approach to BI and BP integration is achieved by using BPM systems as a source of process-related data for BI systems. In recent times, this particular approach has been adopted and promoted by operational BI or ERP (Enterprise Resource Planning) systems. This is because, operational BI recognises the need to synchronise the efforts of decision makers at strategic, tactical and operational levels, to reach a common set of business goals. More precisely, “at the strategic level, executives define strategies and goals. At the tactical level, management in the business units sets direction for their organisations, so that at the operational level individuals can take the right actions” (Smith, 2002). Thus, operational BI also focuses on improving business processes by capturing and analysing operational data for the purpose of taking immediate actions to improve business processes (Imhoff, 2005). However, regardless of their level of sophistication, *process data* provided by BPM system is only *a subset* of the overall enterprise-wide *business data* that is much more complex and richer in terms of the data types, sources and levels of granularity.

However, organisations are yet to realise the full potential of operational BI. “For many companies achieving operational BI simply means viewing operational data from their primary ERP system, namely SAP” (Imhoff, 2005). This approach offers a very limited view of a small set of operational processes supported by a particular BPM system.

Furthermore, any organisational implementation of performance management requires a very good understanding of BPs as well as their relationships in order to find out the relevant indicators and rules, and then determine where the data needed to compute them can be found (Indart, 2005). In fact, the promise of performance management is not about software (in this case BI software), but rather about managing a set of business processes to achieve a desired result (Golafarelli, et. al. 2004). However, in this context, rather than using complex BPM systems, companies often use less sophisticated Business Activity Monitoring (BAM) tools, (White, 2005) designed to provide monitoring of time-critical operational processes and generate alerts without providing the required process context as BPM tools.

Furthermore, several BI vendors claim to offer integration of their BI tools with BPs so these processes can be optimised. In fact, several leading vendors have added workflow support to their tools to enable event and notification-based support. However, “they focus merely on adding process metrics to their product architecture for traditional reporting and analysis” (Grigory, et. al., 2004). Another serious limitation is that they focus exclusively on core, transactional business processes at the operational level.

While acknowledging that it is very important to include BPs, this paper argues that the alignment between BI and BPM should go beyond these processes and, more importantly, beyond technology. This is especially the case with service industry and customer-facing employees who need support to create customer-centered BPs. These are knowledge-intensive and compared to the transactional BPs, they can be used to create a sustainable competitive advantage. However, it is also important to acknowledge that the problem of BI and BPM integration is challenging enough at the technical level, let alone when considered beyond technology. While organisations require new frameworks and methodologies to approach this problem in a systematic way, a very comprehensive review of specialised scientific BPM and BI-related literature as well as very recent IS literature confirms a research gap created by the absence of these, much needed models.

4 Theoretical foundations

The main objective of this section is to introduce two theoretical models that come from the BPM and BI fields, respectively. They are used to set the foundations for a combined, cross-disciplinary framework of BI and BPM integration.

4.1 4.1 The knowledge perspective of BPs

This section provides a brief overview of a model, previously introduced by (Marjanovic, 2007) to describe the knowledge dimension of different types of BPs. We argue that this dimension provides a critical link among BPs, types of decisions people made within these processes and their information needs, as illustrated later in the paper.

Even though it is not often considered during BP analysis and design projects, knowledge is inseparable from BPs. In reality, all processes combine, to some degree, both explicit and tacit knowledge. The explicit knowledge can be written down, easily shared with other people within the same context. Examples include well structured and understood organisational policies and procedures. On the other hand, tacit knowledge are the things known by people but not documented and very hard to externalise. Examples include »know-how«, mental models and experiential insights. Externalisation of tacit knowledge and its gradual refinement result in organisational practices. They are developed over time by employees through their ability to make decisions, solve problems and critically reflect. Figure 1 depicts the theoretical framework used to describe the knowledge dimension of BPs.

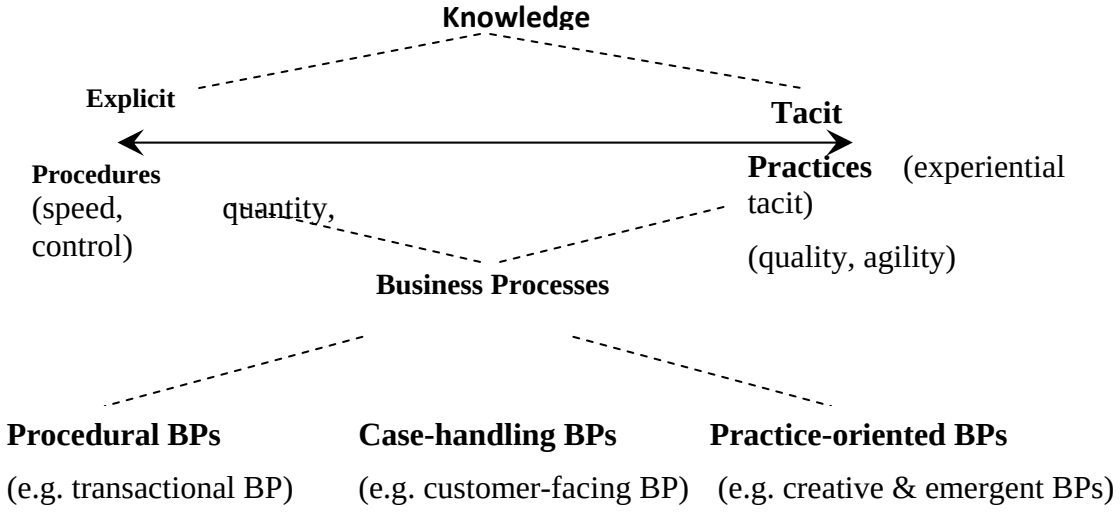

Figure 1: The knowledge dimension of Business Processes

As illustrated by the above figure, highly repetitive, transational BPs have a much more prominent procedural component. Among other things, their procedural component defines the process structure i.e. individual tasks and their order in a particular process. Consequently, technology developers often rely on standardisation and predictability of organisational procedures to design BPM solutions. This is why the existing solutions remain suitable for the transactional business processes, where the main emphasis is placed on speed, number of transactions and control via standardised procedures.

On the other hand, in the *practice-oriented* BPs, their practice component is much more prominent. Here, people develop new experiential knowledge while participating in collaborative tasks and problem solving activities. The explicit knowledge comes in the form of policies that are used to help the participants stay within the normative boundaries of their organisation as well as the wider legislative environment. In the case of practice-oriented BP the main emphasis is placed on process effectiveness, quality and finding creative solutions to meet customer needs.

The third category of BPs, called the *case-handling* BPs also combine procedures and practices. Here, the experiential knowledge comprises practices people develop while handling various non-standard cases of customer-facing BPs.

It is important to note that the initial focus of BPM was on procedural BPs. However, in very recent times, while looking for opportunities for competitive differentiation, organisations are now starting to shift their focus from more-or-less standardised, transactional BPs at the operational level to the other types of BPs that cannot be easily replicated, due to the knowledge and experience of people involved in these processes.

4.2 4.2 Linking decisions and information

The second theoretical framework was only recently introduced by (Davenport, 2008), based on a very comprehensive study of various types of complex decisions in 26 organisations. The main objective of the 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 has 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, as described here:

- *Loosely-coupled information environments*

The main characteristic of these information environments is a loosely coupled relationship between information and decision. Thus, 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 individual initiative and not predetermined by procedures or models.

This is the most commonly used approach by organisations business intelligence systems. However, in order to make these information environments work, more structure or automation may not be appropriate or necessary. Instead, new approaches are required that provide much more than simply making information available.

- *Structured human-decision environments:*

Here decisions are still made by human professionals, 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, 2008). Compared to loosely coupled, these environments have a narrower focus on particular decisions. They are designed to support decision making by, for example providing an additional structure around the decision processes. Obviously this approach is not suitable for all types of decisions and should focus only of those that are critical for the organisational success, due to the cost and complexity involved.

- *Automated decision environments*

These environments include decision rules and algorithms embedded in the key business processes. Decision making is delegated to the rule-engines while humans take care of exception handling. The main objective is to make the process fully automated and therefore very efficient. This only works with decisions that are well structured and

reducible to a set of rules. This means that all information needs could be determined in advance and each decision could be easily operationalised via a combination of automated workflows and rule engines.

Davenport argues that the above three types of environments should be used to guide organisational implementation of BI applications. More precisely, 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 fully understand the relationship between these decisions and information required.

Compared to Davenport's framework for linking decision and information, this paper goes one step further and aims to link processes and types of decisions made in the context of these processes and then, via these decisions, link processes and information needs. We argue that this particular link provides the key starting point for further consideration of BPM and BI integration.

5 A framework for BPM and BI integration

This section describes a theoretical framework that is designed to combine previous two models, with an added value of providing a holistic BPM context to BI supported decision tasks, by explicitly linking processes and information requirements, via decisions. Design of this framework is informed by a very comprehensive literature review and founded in previous case studies conducted by the author in both BI and BPM fields.

Taking a holistic approach, we argue that different types of integration of information, decision and BPs require different type of BP improvement methodologies as well as different processes and strategies for knowledge sharing and transfer that, in turn determine the most suitable training methods for BI/BPM practitioners in this context. Due to the limited space available, this paper will consider only the process improvement methodology required for each type of integration, that is the key non-technical aspect of BI and BPM integration. In fact, the ongoing improvement has been identified as one of the essential factors for gaining the benefits of BI systems (Watson, 2008), but also as the next frontier of BPM (Davenport and Harris, 2007).

The problem of BPM and BI integration could be investigated in the context of different types of BPs and across different organisation levels. This paper focuses on customer-facing BPs as they are much more complex and have a greater potential for competitive differentiation than transactional processes. In terms of their knowledge intensity, these processes range all the way from *procedural* on one end of the spectrum, to *practice-oriented* on the other.

The main research contribution of the proposed framework is that it considers the integration problem along the BP knowledge continuum, linking information and decision with three different types of processes, thus extending Davenport’s framework with processes and knowledge components. The key observation is that decisions are always made in the context of a BP, and by considering the knowledge dimension of this BP, it is possible to determine types of decisions and decision-information links. In other words, it is possible to establish patterns of relationships between processes and decisions, that, when combined with Davenport's framework, enables us to link processes and information. These patterns determine both technical and non-technical

challenges of integration, created at the crossroad of decisions types, information needs and knowledge required. The following analysis summarises these patterns for three different types of BPs:

- ***Procedural BPs:***

- *Decision types:* By definition, these processes involve highly structured decisions with predefined outcomes. In fact, the existence of structured decisions is the main reasons why it is possible to model these processes in advance, including all control flows. Note that in some cases, these decisions could be fully automated, while in the others, human expertise is required to make a selection among the possible outcomes.

- *Process-decision-information link:* When human expertise could be reduced to a set of rules, then fully *automated decision* environment is highly appropriate. While this is already made possible by workflow technology, the added value of combining it with BI, enables creation of much more comprehensive customer profile, to the extent that is not currently possible by BPM systems. However, when human expertise is required than the *structured human-decision approach* is best suited to support the data gathering and analysis phases of decision making (i.e. preparatory phases) while the *fully automated decision* approach is then suitable for decision execution that could be easily handled by workflows.

- *Non-technical challenges of BI and BPM integration:* One of the key challenges is certainly a decision-centered BP improvement methodology. This is very important, having in mind that currently available methodologies predominantly focus on control flows and models rather than decisions made.

Another challenge is related to the management of decision rules including consistency and completeness of the rule-base. This could be a very challenging task, having in mind that on one side, workflow systems have procedural rules that are embedded in the process models, while BI systems are now designed to include declarative rule engines. However, this problem goes beyond rule engines and requires a systematic approach to rule modeling and verification. Another non-technical problem is related to establishment of knowledge-based processes to ensure that rule-based systems are constantly evolving to reflect the changing business environment. Rather than leaving it to knowledge engineers in charge of rule engine, lessons from the field of Knowledge Management confirm that this process requires involvement of people with domain knowledge. In addition to giving tools to domain experts so they could express (or even model) the exceptions they dealt with, into rules, as with any knowledge management system it is also important to create initiatives to encourage development of new rules.

- **Case-handing BPs**

- *Decision types:* By definition, these processes involve semi-structured decisions and situational decision making. While in some cases, decisions involve predefined and deterministic outcomes, the challenge lies with atypical cases where outcomes or even the processes to reach these outcomes, may not be known. This is why they are considered on the case-to-case basis with a decision maker having to interpret the given

»situation« and determine situation-specific information requirements to make a decision accordingly. While in case of procedural processes, these atypical cases are treated as exceptions, in the case of case-handling BPs, situational decision making is the main reason why these processes are considered to be knowledge-intensive.

- *Process-decision-information link:* Irrespectively of the type of the case (typical or atypical), the *structured human-decision approach* is best suited to support the data gathering and analysis phases of decision making (i.e. preparatory phases). After a decision is made by the human expert, then typical cases will require *fully automated decision* approach, while atypical cases may require both *structured human-decision approach* and/or *fully automated approach*. On the other hand, *loosely-coupled information environment*s, while providing a customer-facing employees with more flexibility to explore information resources in an ad-hoc way, are very likely to impact on process performance and prolong a decision making time (i.e. data latency).

- *Non-technical challenges of BI and BPM integration:* Again, as in the case of procedural processes, design and implementation of an ongoing BP improvement methodology is probably the biggest challenge here. We argue that such a methodology consists of a set of human-centered knowledge processes that need to be enabled and facilitated to ensure knowledge co-creation and sharing among employees and ultimately, co-evolution of practices for handling new cases with technical solutions designed to support these practices.

- ***Practice-oriented BPs***

- *Decision types:* By definition, these processes involve unstructured decisions and situational decision making processes where the outcomes are not known in advance. This type of decisions is typically found within emergent BPs, such as for example, various design processes.

- *Process-decision-information link:* While loosely-coupled information environment appears to be most suitable for this type of decisions, it is important to point out that these processes are often highly collaborative in nature, see for example (Marjanovic, 2008). Consequently, this environment needs to support collaborative decision processes.

- *Non-technical challenges of BI and BPM integration:* If these processes are supported by loosely coupled BI solutions, any methodology for improvement of these processes needs to ensure that practices co-evolve with technical solutions. Even more, the chosen methodology also needs to evolve with the accumulated experiential knowledge. Thus, the methodology itself becomes a knowledge-intensive, practice-oriented BP at the meta level. As already pointed out, BP improvement methodologies for knowledge-intensive processes are one of many unexplored challenges of BPM (Davenport and Harris, 2007).

Based on the above brief analysis, it is important to observe that the identified types of *process-decision-information* links, enable us to assess suitability of different BI solutions and determine requirements for different type of information environments.

This is very important, having in mind, that according to Daveport, the most popular BI applications are still designed to support loosely-coupled information environments (Davenport, 2008). The following section describes an exploratory case study used to confirm the theoretical framework introduced here.

6 Research method and case organisation

The above described theoretical framework is currently being used in a series of exploratory case studies. The main research objective of these case studies is to explore the BPM, BI and KM related issues across all four components of the holistic BPM model (i.e. strategy, processes, people and systems components), in the context of customer-facing knowledge-intensive business processes in the service industries.

In line with the exploratory nature of this research, a case study method that involved an interpretive approach was adopted to capture its corresponding contextual richness and complexity (Yin, 2003). In order to capture accurate reflection of the issues under investigation in this context, semi-structured interviews with the stakeholders involved in customer-facing BPs including customer-facing employees as well as BI managers and BP owners in charge of these processes. In addition, technologies used to create information environments were investigated with the help of domain experts in the context of different BP scenarios both standard and case-based, typical and atypical. The data thus collected from different sources was compared and triangulated in order to identify the main characteristics of the information environment in this context, from the BI, BPM and KM perspectives, taking the holistic approach.

While multisite case studies are currently in progress, this paper reports on a case study completed in a large financial institution located in Australia. This organisation was chosen based on their mature stage of BI implementation in the context of their customer-facing BPs, for which they have won several BI industry awards. Due to the limited space available, this paper will focus only on their information environment that was used to confirm the above introduced framework.

Based on data collected and analysed in this case study, this research confirmed that the introduction of operational BI, supported by an enterprise-wide data warehouse, has enabled this organisation to evolve its information environment as well as its competitive strategy, in relation to its customer-facing processes. For example, their initial focus was on implementation of an *automated decision environment.* This environment included very sophisticated BI analytics tool, used for identification of different categories of their customers as well as the rule-based engine that combined with fully automated workflows, was used to select and automated the most appropriate type of processes for each category. Therefore, implementation of the automated information environment has enabled this organisation to compete on the basis of the *procedural* BP (as identified by the previous framework), with different process instances offered to different types of customers. Compared to workflow-based BPM solutions that have been widely used by the financial industry over more than a decade, this type of BI and BPM integration in the context of procedural BPs has created new opportunities for competitive differentiation. This observation confirms the point made by Watson that the importance of technology for competing in the market place is greater for volume-operations rather than complex systems with unique one-off designs. (Watson, 2007). This is because, in the case of companies with high volume operations, the more they know about their customer, the

better processes they can offer, including more efficient and to some degree, personalised BPs.

However, as similar solutions are now being implemented by their competitors, the information environment of this company is gradually evolving from the automated decision to a structured human-decision environment, even for processes that could be easily and fully automated. They are now aiming to "inject" more human knowledge and expertise into their customer-facing BPs. For example, supported by, a complex Active enterprise intelligence system, giving them ready-time access to highly integrated customer-data, these employees are now in a position to combine their own understanding of customer-needs obtained through personal interaction with them, with technology-provided customer insight. The results are personalised processes. Careful investigation of the relationship between information, decision and BPs in this case, confirms that the organisation is gradually moving from the automated to the structured human-decision environment, while moving along the knowledge continuum from the procedural to *case-handling* processes, not driven by exceptions but an opportunity to add-value.

This change is very much caused by their need to create new opportunities for competitive differentiation in a fiercely competitive industry where they cannot compete on the basis of their products alone. Therefore, the increased focus on the structured human-decision environment has enabled them to compete on the basis of their customer-facing processes with value-add provided by their knowledgeable employees. However, it is also important to point out that not all procedural BP could be and should be turned into case-handling BPs. This decision is largely based on the customer's current value and their future potential to bring value. This case study also confirmed that this organisation is interested to move even further along the knowledge continuum, even towards practice-oriented processes. However, they also confirmed that possible technical solutions that would enable flexible implementation of a loosely coupled information environment has not reached the maturity required to example simple, user-driven and collaborative design of practice-oriented BPs. Current developments in the area of Service Oriented Architecture (SOA), conducted independently in BI and BPM fields, may be able to provide the required support in the future.

Finally, this case also confirmed the previous point that organisations do lack systematic methodologies for BP improvement of decision-intensive processes supported by BI. However, further data collection and analysis is required in order to further confirm and investigate this problem.

7 Conclusion

While the issue of BPM and BI integration is becoming more and more important, especially with the very recent raise of operational BI, current integration efforts remain mostly at the level of technology. This paper argues that BPM and BI integration should be investigated from a holistic perspective rather than reduced to technical solutions. It aims to pose the key questions as to why and where organisations need BI & BPM integration and what kind of integration would be most suitable for different types of business processes. Only when such a question is asked, possible technical integration of BI & BPM tools could become a part of an answer.

This paper aims to offer a starting point for an evolving roadmap of BPM and BI integration that goes beyond technology. Our current and future work involves exploratory case studies in different service organisations in the context of their customer-facing knowledge intensive processes. The main objective is to determine patterns of integration across all four components of the holistic BPM model, namely strategy, people, processes and systems components as well as to identify the best practices and the associated critical success factors.

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