Investigating the Application of Real-time Business Intelligence and Facilitating its Justification through a Proposed Conceptual Model

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By

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Abstract

While traditional Business Intelligence (BI) environments have for a long time assisted organizations with their information requirements, they have started becoming increasingly incompatible with the pressures of current business environments. This is mainly because they are geared towards analysis of historical information, and that they are limited in their ability to close the gap between information and action. Consequently, this instigated a movement towards real-time BI systems. Although they overcome the setbacks of traditional BI, and offer a host of value adding benefits to organizations, their implementation has said to be hampered due to their technological complexities, and has required changes to the business environment, as well as the high costs required to put them in place. In addition, the justification of IT investments still remains a common problem as they provide many intangible benefits which are incompatible with traditional (financial) IT benefits measurement models.

For this reason, the research set out to investigate and understand the technological components and organizational changes surrounding real-time BI in order to shed light on these issues. This study also aimed to further the understanding of how real-time BI can be justified as a prudent investment by looking at methods that could overcome the setbacks of traditional IT evaluation models. To further facilitate justification, application areas and benefits of real-time BI were also explored. Data was collected by conducting semi-structured interviews with organizations that had implemented or were implementing real-time BI systems. In-depth interviews were conducted with 5 organizations from multiple sectors of industry. A qualitative thematic analysis approach was then used to test the findings that emerged from literature, and to also investigate the issue(s) further.

The study confirmed that real-time BI is likely to require major changes to the technical architecture, which may involve the acquisition of new tools and technologies. Alongside this, there are also several issues and requirements at the business level which need to be addressed. A strong concept which emerged from these findings is that they correlate to phases of BI maturity models. Evidently, these can be used to guide organizations towards evaluating their readiness for moving into real-time BI. Furthermore, a comprehensive business case was suggested that includes both tangible and intangible IT benefits in its assessment. The research also explored a wide range of practical real-time BI applications and analytics that were being applied across industries. Process intelligence was found to play a fundamental role behind many of these analytics.

The study reveals that real-time BI has the ability to offer significant and measurable improvements, help organizations remain competitive, and in the long run, drive strategic business objectives from a grass roots level. In light of this, it proposes a conceptual model that eradicates many of the concerns around the complexity of implementing a system of this nature, and can ultimately assist practitioners in producing meaningful and insightful justification for real-time BI.

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Finally, to all my friends who gave me encouragement throughout this process, and gave me motivation to persist through the tough times, I thank you.

Declaration

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Definition of Terms

Term	Definition
Algorithm	An algorithm is a procedure made up of a finite set of steps for solving a particular problem.
Application	An application is any computer program.
BAM	Business Activity Monitoring (BAM) is software that is used to monitor activity as it is executed in business systems.
Business process	A business process is a set of related and structured activities that produce a specific goal (service or product).
Cache	Cache refers to the storage of data that is retrieved frequently in order to improve the efficiency of the process.
CRM	Customer relationship management is a class of software applications used to better manage an organization's customers.
Dashboard	The user interface of a real-time executive information system that is designed to display information on a single page, showing graphical representations of the current status, and historical trends of an organization's Key Performance Indicators (KPIs).
Data source	A data source is a term given to any repository of data, both internal and/or external, for a system.
Database	A database is a technology that serves to store, manage, and retrieve information.
Down-time	Down-time refers to the period when a system is unusable.
ERP	Enterprise resource planning is an integrated computer system that serves to manage the internal and external resources of an organization.
ETL	Extract, transform and load (ETL) is a process used for storing data in a database / data warehouse.
Fact table	A fact table is the central query table that consists of measurements, metrics or facts of a business process. It is used in OLAP database designs.
Hardware	Hardware refers to the physical components that make up a computer.
ICT	Information and communication technology (ICT) is an umbrella term that is concerned with how information is processed and communicated.
KPI	A KPI is the metric that is used to measure business process performance.
Information System	An information system refers to the interaction between people, processes, and technology. It is not only a technology but also the way in which an organization's people and business processes interact with that technology.
Latency	Latency, in this context, refers to the time delay experienced when data is sent from one point to another.

Legacy system	A relatively old standard of technology that is outdated. It is sometimes still used by some organizations because it contains important information.
Log data	This is the data that is extracted from web-server systems.
MOLAP	Multidimensional Online Analytical Processing is an alternative to ROLAP whereby data is queried from a pre-computated database.
OLAP	OLAP (online analytical processing) refers to a database technology used to assist users in interactively manipulating and retrieving data in order to answer business-questions.
Query	A query is a user-specified question that used on a database of information.
ROLAP	Relational Online Analytical Processing is an alternative to MOLAP in which pre-computation of data is not required as queries are created on demand.
SLA	A service-level agreement is a contract that stipulates the agreed levels of service between the user and the service provider.
SOA	A set of principles for the design of interoperable software services.
Transaction data	Data that describes an event and that has a time dimension, a numerical value, and that is associated with object(s).
Update	Update refers to when something (i.e.: database) is brought to the latest/most current state.
Up-time	Up-time refers to the period when a system is active and usable.

Table 1 - Definition of Terms

Chapter 1 - Introduction

While Business Intelligence (BI) systems have delivered decision-support and analytics to organizations, today's business environment calls for solutions that can make faster, more accurate, and intelligent decisions (Venter, 2005). As the need for this has grown however, so has the need for data that is more current and easier to act upon. Consequently, BI has seen an expansion into a relatively new level, real-time BI (or near real-time BI). As the technology has evolved, its benefits and application areas have become more explicit and better documented. Heretofore however, there are still no best practices for its implementation, or frameworks that can guide organizations towards its adoption. Consequantly, many studies suggest that the current adoption of real-time BI is hindered because of a lack of clarity surrounding the underlying technical components as well as the significant costs associated with its implementation (Agrawal, 2008; Andrews Consulting Group, 2011). In addition, the justification of BI investments still remains a difficult problem to address. The intangible nature of BI benefits makes it difficult to demonstrate financial value, therefore compromising BI's justification (Lönnqvist & Pirttimäki, 2006).

The intention of this research is to therefore explore and uncover the process of implementing real-time BI, from a technical and business perspective. It will look at where real-time BI has been applied in organizations and what kind of value it yields. Furthermore, benefits and value areas will be assessed in terms of how they influence the justification of the investment. It will also be important to assess various IT evaluation methods in order to propose a conceptual model that can help facilitate the justification of a real-time BI investment.

1.1 Background to the Problem

Venter (2005, p. 149) suggests that "the ability [for] companies to make fast and accurate decisions in an ever changing environment is imperative for [their] success". It is thus important that the necessary "decision support infrastructures [are put in place] in order to face these challenges" (Sahay & Ranjan, 2008, p. 28). Those who can do this, Ranjan (2008, p. 463) believes, "will distinguish themselves by the capability to leverage information about their market place, customers, and operations to capitalize on the business opportunities".

Evidently, the demand for real-time BI systems is growing, yet there are several reasons that are inhibiting their application. For instance, Kilcourse and Rosenblum (2008) conducted research into organizational inhibitors of real-time BI adoption and found that some of the reasons include: difficulty in calculating return on investment (ROI), cost of integration, lack of confidence, user resistance, poorly defined business processes, and platforms that are not flexible for change. In addition, business process re-engineering, a common requirement for enabling real-time BI, was rated the fifth highest management issue in the United States, second in Europe, and seventh in Asia/Australia (Luftman & Ben-Zvi, 2010, p. 6).

At the technological level, issues such as enterprise-wide system integration, reduction of latency, and acquisition of new tools and technologies are just some of the requirements for enabling a real-time BI environment (Gangadharan & Swamy, 2004). Organizations also need to ensure that they have the skills to use and implement these. Furthermore, there are several different ways in which real-time data can be enabled; organizations need to assess these options and plan for their respective technological configurations (Langseth, 2004).

These concerns certainly support Agrawal's (2009) claims that the adoption of real-time BI is hindered due to a lack of understanding of the technical components and the high costs associated with real-time BI implementation. Further, while implementing real-time BI can be very costly, it is also not always necessary because organizations do not always need to reduce latency to zero and do not always need to take and implement decisions in real-time (Ioana, 2008). As such, Schneider (2006) stresses that because low latency costs money, the business decisions to be made with reducing latency must justify the investment. The justification of BI investments however, remains a difficult task due to the nature of their benefits (Soh & Markus, 1995).

1.2 Statement of the Problem

The intention of this research is to analyze and evaluate the issues surrounding real-time business intelligence implementation, from a technical and business perspective, as well as to formulate a justification for its investment through the demonstration of credible business benefits.

1.3 Purpose and Objectives of the Research

1.3.1 Purpose

The purpose of this research is predominantly exploratory as it seeks new insight into the real-time BI field. Still a relatively grey area, it is the opinion of the researcher that it is important to seek a greater understanding of real-time BI in order to address the need for theory. More specifically, there currently exists no literature, which the researcher could find and/or obtain access to, which investigates the pre-adoption considerations for real-time BI. As such, the research aims to make the potential value of real-time BI better known and assist in providing evidence and guidelines for practitioners who wish to evaluate its benefits and make a case for it in their organizations. The research will therefore not only add to the literature, but also contribute new ground in the field.

1.3.2 Objectives

The primary objective of this research is to produce a model or framework which serves as a guideline for organizations that are planning on moving into the real-time BI sphere. The purpose of the model would serve to inform and equip organizations with the necessary information they should know before pursuing such an investment. The type of information will include challenges and obstacles that real-time BI implementation can bring about, areas where real-time BI can, and has, been applied, what benefits it can provide, and how it can be justified as a prudent IT investment.

In order to achieve the desired objective, the research will be supported by the following sub-objectives:

1. To gain a thorough understanding of the practical challenges and considerations of real-time business intelligence implementation.
2. To identify application areas and analytics of real-time business intelligence, and understand how they are enabled in such an environment.
3. To investigate how a real-time business intelligence project is justified as an IT investment and the role that business benefits play in the business case.
4. To investigate how the introduction of real-time business intelligence affects users, and how decision-making is influenced at strategic, tactical, and operational levels.

The first objective aims to flesh out, from literature and interviews, what organizations should know prior to implementing real-time BI. This would include various considerations, requirements, as well as challenges. Secondly, the research aims to identify what kinds of analytics are being applied with real-time BI, as well as to understand how they are enabled in this environment. The third objective aims to investigate how a real-time BI project is justified as a prudent investment, and how its benefits influence the approval and adoption decision. The fourth objective aims to assess how the introduction of real-time BI affects its users, and how decision-making is influenced at different organizational levels. This will be done by condensing the findings to develop a conceptual model or guideline that can be used by organizations that are planning a real-time BI project. It is the opinion of the researcher that this should facilitate the justification process and improve the likelihood of approval.

1.4 Overview of the Study

Following the introductory chapter, the second chapter presents an overview of the supporting literature relevant to this topic. Chapter Three will then present the design of the research, including the research questions, methodology, approach to sampling, data collection, and how the analysis will be conducted. The overview of the analysis process, including the outlined themes, will be discussed in Chapter Four. The analysis results will then be presented in Chapter Five which is broken into five main components of analysis. Chapter Six provides the overall discussion of the research, and concludes by proposing a conceptual model as a solution to the study's objective. The final chapter details the conclusion, a summary of the findings, a reflection of the research process and limitations, the implications and recommendations of the study, and suggestions for further research opportunities.

Chapter 2 – Literature Review

2.1 Introduction

The purpose of this chapter is to describe as much as possible about what is already known or what has been discovered relevant to this research study. As such, it is divided into the following sections:

- The first section examines why organizations need BI, how it is used, the components behind its architecture, and also its shortcomings.
- The second section investigates why organizations move towards real-time BI.
- The third section looks at various elements of real-time BI, including data latency, the components behind its architecture, how users interact with it, and various implementation challenges and considerations.
- The fourth section analyses several case studies of organizations that have applied real-time BI systems, as well as several types of analytics.
- The fifth section is two-fold; it first explores the benefits of real-time BI, and then looks at various frameworks that can assist in the measuring of its benefits for the purpose of justifying it as an investment.

2.2 Business Intelligence

2.2.1 The need for Business Intelligence

Venter and Tustin (2009, p. 91), and many others, speak of a common problem faced by many organizations today. It is due to their unprecedented growth that they collect copious amounts of internal and external data. Because this information is easily collected, it continues to grow over time and becomes increasingly complex in structure, as well as in semantics (Nguyen, Schiefer, & Tjoa, 2005, p. 77). Nguyen *et al.* (2005, p. 77) state that "strategic decision makers are being exposed to the huge inflows of data and information from their various resources [and are at the same time] under rigid time constraints to make the right decisions". Gartner, an information technology (IT) research and consulting organization, predict that "through 2012, more than 35% of the top 5000 global companies will fail to make insightful decisions about significant changes in their business and markets due to underinvestment in information infrastructure and business user tools" (Bitterer, Rayner, & Neely, 2010, p. 3).

Organizations normally have many systems and data sources that can reside in various locations and on multiple platforms (Sahay & Ranjan, 2008). Sources of data could include, for example, databases in sales, supply chains, and call centres around the organization. Data marts are also types of databases that reside in various departments but which are intended for specific departmental needs. These systems capture large volumes of data, but often do not have the capabilities to access the right information in a timely manner, thus affecting the quality of decision-making (Ranjan, 2008). It is evident that there is a need for a technology that can overcome the fragmented nature of information systems, and provide a means to extract accurate information timeously.

Gangadharan and Swamy (2004, p. 139) stress that "finding ways of bringing together and making sense of the vast amounts of data flowing within and across the extended enterprise is becoming a key business success factor". The key is finding a way of bringing together the various enterprise operational systems into one location (Gangadharan & Swamy, 2004, p. 140). To do so, organizations typically create a data warehouse, which, in its simplest definition, acts as a central repository that integrates both internal and external data sources from which strategic analysis can be conducted (Chaudhuri & Dayal, 1997).

2.2.2 Leveraging Business Intelligence

Whereas the data warehouse (DW) is typically involved in the physical storage of data, BI refers to how that data is leveraged to make better business decisions (Hinshaw, 2004, p. 32). Although there is no commonly accepted definition of the term BI, Ranjan (2005, p. 60) refers to it as a "broad category of applications and technologies for gathering, providing access to, and analyzing data for the purpose of helping enterprise users make better business decisions". Negash and Gray (2003, p. 3190) refer to BI as systems that "combine data gathering, data storage, and knowledge management with analytical tools to present complex and competitive information to planners and decision makers". Based on the various definitions, Venter and Tustin (2009, p. 89) propose four defining characteristics of BI:

- It refers to both internal and external forms of information.
- It adds value to information through appropriate gathering, analysis and dissemination.
- It is driven by technologies.
- It facilitates decision-making.

In essence, organizations will use BI tools to "distinguish themselves by the capability to leverage information about their market place, customers, and operations" (Gangadharan & Swamy, 2004, p. 140). Furthermore, due to the nature of today's competitive, globalized, and highly uncertain world, "the quality and timeliness of an organization's [BI] can mean not only the difference between profit and loss, but also even the difference between survival and bankruptcy" (Ranjan, 2008, p. 461; Lönnqvist & Pirttimäki, 2006).

In doing so, they are able to enhance market orientation by being better equipped to "anticipate, react to, and capitalize on environmental changes" (Venter and Tustin, 2009, p. 148). The ability to leverage external information is also a particularly important activity in achieving competitive intelligence. Competitive intelligence is one aspect of BI that allows organizations to ensure "competitiveness in the marketplace through a greater understanding of competitors and the overall competitive environment" (Negash & Gray, 2003, p. 3193).

Furthermore, it was estimated by Gartner that BI deployments would grow from 11 to 29 percent between 2002 and 2006 (Gangadharan & Swamy, 2004, p. 142), and were again predicted to double within the next five years (Bitterer *et al*., 2010, p. 8).

2.2.3 Components of Business Intelligence Systems

Sahay and Ranjan (2008, p. 32) stress that the key to successful BI rests in the ability of an organization to pool together its data sources into an enterprise-wide data warehouse. In the same study, a basic BI architecture (Figure 1) is proposed which consists of four major components that make up BI.

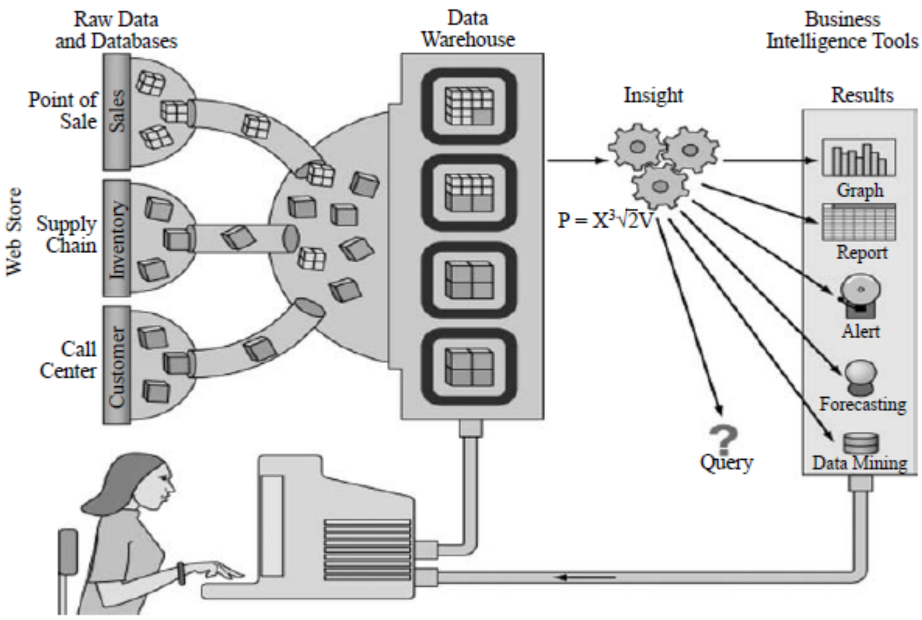

Figure 1 - Basic understanding of BI (Sahay & Ranjan, 2008, p. 31)

The *data warehouse* is the core element in a BI architecture. The data warehouse "supports the physical propagation of data by handling the numerous enterprise records for integration, cleansing, aggregation and query tasks" (Sahay & Ranjan, 2008, p. 32). *Data sources* are any systems that produce data; these normally reside in various locations and sometimes on different platforms. Sources of data could include, for example, databases in sales, supply chains, and call centres around the organization. *Data marts*, although not illustrated in Figure 1, are types of databases that reside in the various departments and which are intended for specific departmental need(s). These too form a large portion of the data sources. Finally, *query and reporting tools* provide a means of extracting, viewing, and making sense of the data in multiple ways. Technologies such as OLAP (online analytical processing), provide "multidimensional, summarized views of business data" (Sahay & Ranjan, 2008, p. 32) in order to discover trends and patterns used to optimize business decisions.

2.2.4 Some Limitations of Business Intelligence

Organizations, however, are no longer satisfied with knowing what has happened, but are more concerned with the underlying reasons behind it (Ranjan, 2005, p. 67). In recognition of these challenges, organizations are investing in BI in order to adapt "from an environment that is reactive to data, to one that is proactive" (Ranjan, 2008, p. 461).

Traditional BI architecture, however, is in many ways limited in its ability to offer the desired proactive ability. For example, information is not always up-to-date because updates to the DW are executed in batch modes. Typically, before information is stored in the DW, it needs to undergo an ETL (extract, transform, and load) process. Data is first extracted from the various operational systems, transformed (cleaned) into the correct format, and loaded into the database. Not only is the ETL process an overly time-consuming and resource intensive task; but when conducted on a large scale, it can become a logistical challenge. As such, "ETL processing is often executed in batch mode at non-peak times (e.g. overnight), causing time-lags between the recognition of a business event and its delivery for analysis purposes" (Andrews Consulting Group, 2011; Seufert & Schiefer, 2005, p. 922). Consequently, because this limited up-time, early DWs were often only updated on a monthly basis (Raden, 2003, p. 5). Nguyen *et al.* (2005, p. 77) add that out-dated information is simply not suitable for applications that require analysis at the speed of the business's operations.

In addition, with the pace of the business environment and rapidly changing customer demands and technologies, "decision-makers are no longer satisfied with scheduled analytical reports, pre-configured key performance indicators (KPIs) or fixed dashboards" (Azvine, Cui, & Nauck, 2005, p. 214), but require actionable information from real-time performance data. Decision-makers are now prompting for an environment where business questions can be answered immediately, without relying on IT departments to formulate business questions and provide reports. The problem is that, as useful as these reports may be, "they don't reflect real-time information needs" (Rash, 2010, p. 12), nor do they "address time sensitive monitoring and analytical requirements" (Nguyen *et al.*, 2005, p. 77). Furthermore, BI does not provide the ability to link action back into business processes automatically (Azvine *et al.*, 2005).

Organizations with large in-flows of data are said to also experience a bottleneck effect where information cannot be turned into action in a timely manner. The implication with this, is that "if BI software cannot link back into processes automatically and drive business parameters, the transition from information [into] action can only be manual and can require long periods", after which, process change may no longer be appropriate (Azvine *et al.*, 2005, p. 216).

It is clear that, because traditional BI systems rely on historic data and support mainly reactive business responses; they are becoming increasingly incompatible with the pace of the business environment. This calls for a more real/near real-time environment where organizations can operate in a proactive manner and automate many of their analytical responses.

2.3 Advances into Real-time Business Intelligence

Although BI systems have certainly been of benefit, the fast-paced and highly competitive business environment now has organizations demanding quicker access to key information. A survey by Gartner (Figure 2), demonstrates how the demand for instantaneous data availability has grown from 11% to 29% between 2002 and 2006 respectively.

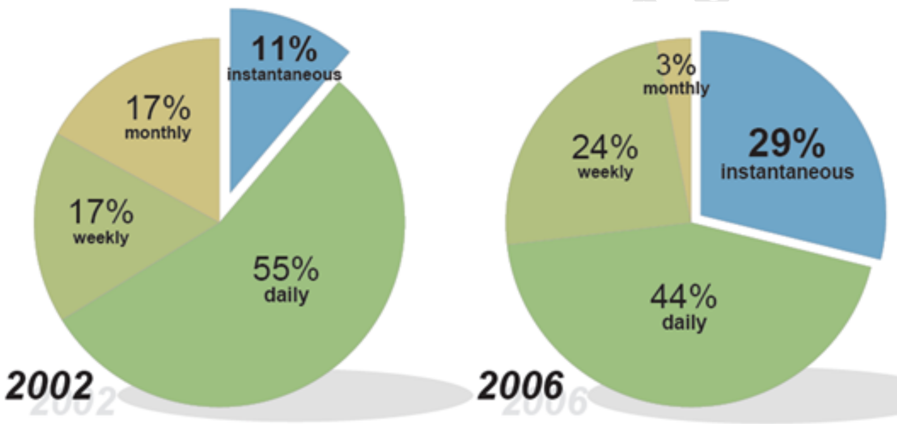

Figure 2 - Gartner Survey of 540 organizations (Sybase Informatica, 2005)

Evidently, it is becoming increasingly important for organizations to “strive towards reducing the time needed to react to business events” by reducing the “latency between recognizing a relevant business event and taking appropriate action” (Seufert & Schiefer, 2005, p. 920). In order to achieve this, there is a need for an enhanced BI architecture that can “deliver business information in a range from milliseconds to a few seconds after a business event” (Sahay & Ranjan, 2008, p. 35) so that corrective action can be taken in a timely manner. Therefore, BI has seen an evolution into real-time BI.

2.3.1 The Evolution into Real-time Business Intelligence

As is the case with many technologies, real-time BI is an outcome of an evolutionary process (Ioana, 2008). *Operational transactional systems* were the first versions, but because they are static in architecture, structure and logic; they did not suffice for long. The second movement saw the appearance of *analytical applications* that allowed organizations to obtain feedback through customizable business questions. It is here where the concept of DWs, BI, and business performance management systems came about. As already mentioned, the competitive and dynamic business environment forced organizations to react faster to changing conditions. BI however, could not provide the necessary functionality to "modify or influence the operational systems" and business processes (Ioana, 2008, p. 33). Consequently, there has been a third movement into *operational BI* which allows information and knowledge, obtained from the analytical systems, to be used "not only for decision making but to improve the business processes and to adapt the operational systems for better responsiveness to changing conditions in the market" (Ioana, 2008, p. 34). Operational BI is able to achieve this by optimizing business operations on a daily basis through intraday decision-making. With operational, or process intelligence, "data is analyzed as soon as it enters the business" (Ioana, 2008, p. 35). Evidently, there has been expansive growth, both in the number of BI products and services offered and in the adoption of these technologies by industry (Chaudhuri & Narasayya, 2011).

Castellanos, Medeiros, Mendling, Weber, and Weijters (2009, p. 467) define process intelligence as the "application of Business Intelligence techniques to business processes and comprises a large range of application areas spanning from process monitoring and analysis to process discovery, conformance checking, prediction and optimization". Interestingly, this can be seen as the merging of business process management and BI. In other words, analytical components can be integrated with business processes in order to achieve efficiency through better monitoring and control. In addition, this configuration uses BAM (Business Activity Monitoring) techniques that are used to monitor activity as it is executed in business systems, in real-time. This kind of activity is typically derived from business processes, operations, and transactions. By doing so, these monitoring techniques provide real-time access to critical performance indicators of ongoing processes. Further, "if correlations among generated events foreseeably influence the performance outcome upon completion of the process, the monitoring system [can] predict the final performance based on the current status and real-time progress of the process in order to enable more proactive operation" (Kang, Jung, Cho, & Kang, 2011, p. 653).

Furthermore, live process data can be contextualized with historical business data, derived from the DW, allowing management to make informed decisions. It is therefore evident that BI has significantly evolved to a level where it can monitor live processes using operational intelligence, event processing and BAM technologies. Reactions are now possible in real-time where the latency, between recognizing a business event and taking appropriate action, is significantly minimized (Seufert & Schiefer, 2005, p. 920). The major benefit of this is that action can now be taken before problems can actually materialize.

Table 2 shows the three types of business intelligence systems, as they have evolved. When juxtaposed with the above-mentioned issues, it becomes clearer that, in response to the new dynamics of the market; there is a growing need for timely data. Consequently, both 'time framework for analyses' and 'query response time' characteristics have rapidly decreased. In parallel with this, the need for 'data freshness' has been achieved by subsequently decreasing 'data latency'.

	Business Intelligence Type		
Characteristics	**Strategic**	**Tactical**	**Operational / Real-time**
Business Objectives	Long term (strategic)	Tactical	Manage and optimize daily business operations
User Type	Top/senior manager, financial analysts	Top/senior manager, financial analysts, operational managers	Top/senior manager, financial analysts, operational managers, operational users
User Population	Tens	Tens - Hundreds	Tens - Thousands
Time framework for analysis	Months – Years	Days – Months	1 day / seconds
Data Type	Historic	Historic	Historic, current (zero latency)
Query Response Time	Hours – Minutes	Hours – Seconds	Minutes - Seconds
Latency	High	High – Medium	Low
Data Freshness	Old	Old – New	New

Table 2 - Business Intelligence Types (Ioana, 2008, p. 36)

2.4 Real-time Business Intelligence

Azvine *et al.* (2005, p. 216) define real-time BI as providing the same functionality as traditional BI, but which "operates on data that is extracted from operational data sources with zero latency, and [which] provides means to propagate actions back into business processes in real-time". The fundamental business-driven purpose of real-time BI, put simply, is to increase revenues and decrease costs (Watson, Wixom, Hoffer, Anderson-Lehman, & Reynolds, 2006).

One of the major benefits of real-time BI systems is their automated analysis capability which is able to automatically "sense, interpret, predict, automate and respond" (Sahay & Ranjan, 2008, p. 34) to business events. Real-time BI can automatically "compare current business events with historical patterns to detect problems or opportunities" (Sahay & Ranjan, 2008, p. 35) in order to take corrective actions and optimize business processes. Organizations are now able to predict and prepare for change by "establishing the status of [their] business at any moment in time in relation to its performance objectives" (Ranjan, 2008, p. 468).

2.4.1 Right-time/real-time

Strictly speaking, "real-time implies that any change [that occurs] in a source system is automatically and instantaneously reflected in the data warehouse" (Nguyen *et al.*, 2005, p. 78). This however, is not necessarily the case. Typically, organizations will have different understandings and expectations of what 'real-time' is. For one organization, real-time could mean data that is not older than one hour, whereas it could be as little as several minutes for another. Thus, data will only need to be as fresh as its respective business requirements (Watson *et al.*, 2006, p. 2). As such, the definition of real-time is subjective and will "vary from company to company and from application to application" (Raden, 2003, p. 3).

Normally, real-time will be defined by a service-level agreement where the time element will be explicitly stated. Ioana (2008, p. 36) suggests that, when defining an optimum time frame for any process, it is important that the interval (latency window) correlates to the business' needs in order to achieve the best cost-risk ratio. For example, when setting the requirements for their real-time system, Continental Airlines defined a late flight as being one that departed or arrived fourteen minutes from its scheduled time (Watson *et al.*, 2006, p. 14). This was derived through a comprehensive financial and strategic analysis that determined an appropriate latency window for one specific requirement. In light of this, many authors have suggested that the terms 'right-time' or 'near real-time' is therefore more appropriate (Watson *et al.*, 2006, p. 2).

2.4.2 Latency

In most cases, as data increases with age it equally decreases in value. In other words, fresher data (low latency) is far more valuable than older (high latency) data (Watson *et al.*, 2006, p. 3). Latency, in this context, refers to "the temporal delay between the moment of an event initiation and the moment the event's effects show up" (Ioana, 2008, p. 34). The goal of real-time BI is to "reduce the latency between when operational data is acquired and when analysis over that data is possible" (Chaudhuri, Dayal, & Narasayya, 2011, p. 95).

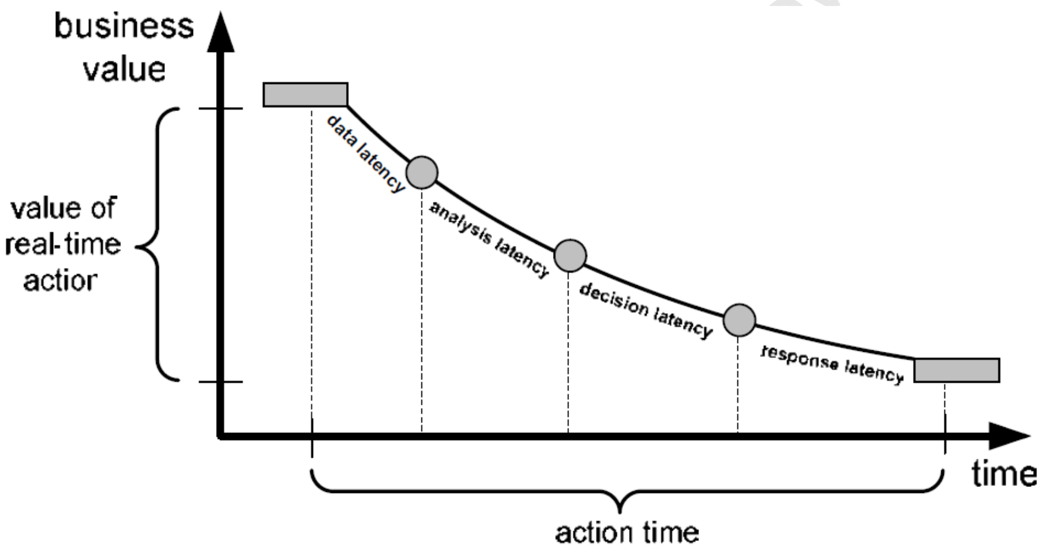

Figure 3 - Types of Latency (Seufert & Schiefer, 2005, p. 921)

To illustrate how latency affects the value of data, Figure 3 demonstrates how it (data value) diminishes over time. *Data latency* refers to the length of time between a business event and when the data is ready for analysis in the warehouse. The time between the storage of the data and when it is actually analyzed, through software applications, is *analysis latency*. The time from receipt of the analyzed information, to the point of selecting an appropriate response strategy, is referred to as the *decision latency*. Finally, the time needed to execute the strategy and monitor its outcome is called the *response latency* (Seufert & Schiefer, 2005, p. 921; Watson *et al.*, 2006, p. 3). It is therefore understood that the "latent value of real-time data is lost if it is not exploited within a very short time" (Raden, 2003, p. 3).

Reducing action time in order to increase business value is therefore the critical objective for real-time BI (Eckerson, 2004, p. 31). Kilcourse and Rosenblum (2008) advise that, in order to close the loop between an organization's transactional systems and its data analysis capabilities, they must move towards an engineered approach to their business processes. This will ensure that interactive and fast-moving business processes are infused with the right actionable information, at the time and place that it is needed. Therefore, reducing data and analysis latency primarily depends on technical solutions, whereas reducing decision latency requires changes in business processes and how people use information (Watson *et al.*, 2006, p. 3). Data latency can be reduced by changing "from a batch-oriented to an event-driven update of the data warehouse" whereby data that represents a certain business event will be stored as soon as the event is recognized in an operational system (Seufert & Schiefer, 2005, p. 921). Alternatively, data latency can be reduced through the implementation of an Operational Data Store (ODS) which, unlike a DW, does not require extensive cleansing and consolidation. Instead, it stores a limited scope of data, thereby allowing near real-time updates (Melchert, Winter, & Klesse, 2004). Analytical capabilities enabled by real-time BI, such as sense & respond, are also aiding in the reduction of decision latency (Nguyen *et al.*, 2005). These will be discussed in the latter half of this chapter.

2.4.3 Components and Architecture of a Real-time BI System

Implementing a real-time BI system requires several new components to supplement the traditional BI architecture; here two proposed architectures, of Nguyen *et al.* (2005) and Hang and Yong (2010), will be explored. Further, two relatively new advances in real-time BI architectures, in-memory analytics and a service-oriented approach, will also be discussed. Nguyen *et al.* (2005, p. 79) propose an enhanced BI architecture that supports the delivery of real-time requirements. These requirements are:

- Low-latency data.
- Continuous data integration (near real-time capturing and loading of data from different sources, and event-based action triggering).
- Analytical environments, based on analysis engines, that are highly available and which are not restricted by latency windows.
- Active decision engines capable of recommending actions when exceptions or situations are discovered (rule-driven).
- High availability and scalability to deal with the increase in performance requirements and number of users.

Achieving this requires "a complete business intelligence process to observe, understand, predict, react to, reorganize, automate and control the feedback loops in real-time" (Nguyen *et al.*, 2005, p. 79).

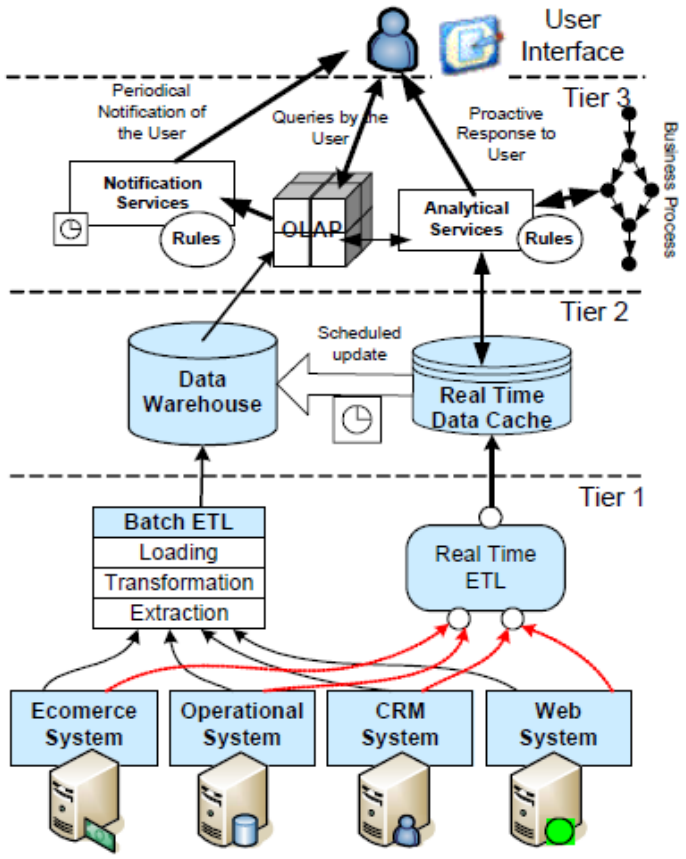

Figure 4 - Real-time BI Architecture (Nguyen *et al.*, 2005, p. 79)

A fundamental component in achieving this, as seen in Figure 4, is the *analytical services* which are responsible for the handling of the continuous stream of data that is fed from the *real-time data cache*. Using a rules-engine, analytical services can constantly analyze data patterns and discover situations and exceptions. The key issue is implementing a continuous feed of data abreast with the traditional (periodically updated) DW. Data, from the various sources, typically undergoes an ETL process before it is stored in the data warehouse. This data is then queried using OLAP (through either MOLAP or ROLAP) and reporting tools. The problem is that the ETL process is designed for batch updates that take place when the DW is offline. This is because creating a copy of a data source requires too much time and resources (Tank, 2012). This however, would be incompatible for real-time BI. As such, there needs to be a concurrent process that allows both historic and live data to co-exist within a single architecture.

Achieving this requires a real-time data cache "which serves as a staging area for managing [both] real-time updates [as well as periodical] updates to the data warehouse" (Nguyen *et al.*, 2005, p. 79). In light of this, analytical services are able to obtain live data from the real-time data cache, and contextual data from the OLAP cube. It is this combination that allows users to understand what is happening now (live data), and influence what should happen next (historical data) (Oracle, 2010, p. 4). The key is therefore to provide information along with its entire context (Hackathorn, 2002, p. 25). Alternatively, Tank (2012) states that a popular technique to enabling efficient ETL processes is by enabling change data capture. This is an approach to data integration that is based "on the identification, capture, and delivery of only the changes made to operational/transactional data systems" (Tank, 2012, p. 3). Finally, at the analytical/user-interface layer, several capabilities are available for viewing the data and propagating actions back into the system.

The second architecture, as proposed by Hang and Fong (2010), shows many similarities to the former. At its core, it is based on two requirements; the system's response time must stay under a threshold that is less than the action-taking time, and the rate of data processing must be higher than the rate at which it is produced (Hang & Fong, 2010, p. 1). Furthermore, the architecture is structured around a four-layer framework (Figure 5).

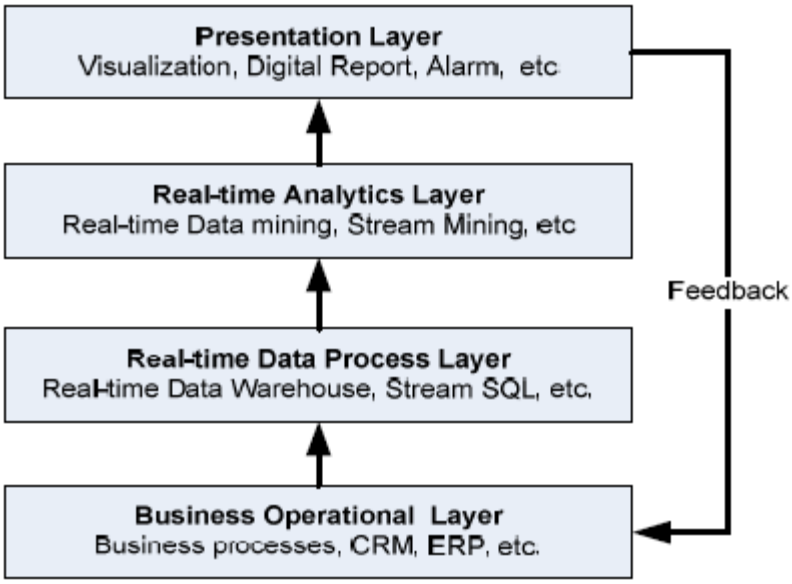

Figure 5 - Four Layer Framework for real-time BI (Hang & Fong, 2010, p. 1)

The *operational layer* has two primary functions, BAM and real-time process tuning. The key here is that a feedback link exists allowing the system to automate responses, optimize and re-engineer process, and monitor people and systems for conformance. The *real-time data process layer* is responsible for feeding the analytics layer with data that is created at the operations layer, and must do so within a set time constraint. While traditional BI systems would require human intervention to drive or configure information at the analytics layer, *real-time analytics* relies on analysis tools and automation techniques in order to reduce action-time latency. In order to do this, four main data mining algorithms and methodologies are proposed: clustering, classification, frequency counting, and time-series analysis. At the *presentation layer*, information is displayed to users in an interactive and high-level manner in order to shorten action latency. To do this, it can present information in variety of ways, using KPI dashboards.

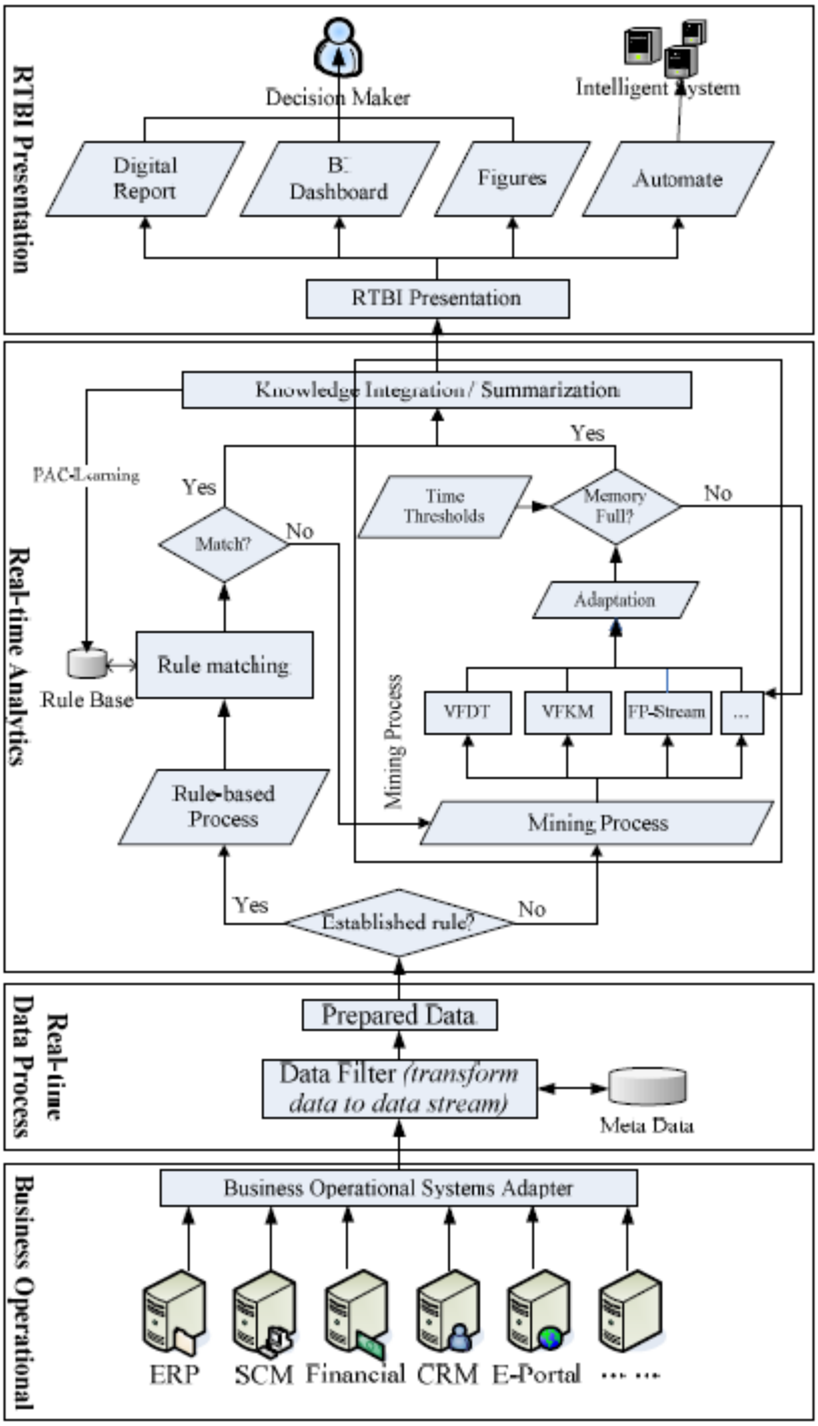

Figure 6 - Real-time BI architecture (Hang & Fong, 2010, p. 2)

The architecture for the proposed system (Figure 6) is based on the above-mentioned four-layer framework. In short, the real-time BI system first collects historic data from the existing information systems in the organization. At the data process layer, the new input data is then monitored, but will also be transformed to its correct form if it is necessary. Once in the analytics level, the system determines whether the data relates to an already established model (or set of business rules). If it does, then the system automatically matches it with its respective rules engine and subsequently returns a BI result. Otherwise, it will be passed through a series of data mining techniques. Finally, the discovered information is then summarized and presented in its appropriate form at the presentation layer.

These architectures however are still highly dependent on the traditional BI configuration in terms of having a separation in operational and analytical systems (Acker, Gröne, Blockus, & Bange, 2011). A relatively new architecture called in-memory analytics "will allow operational data to be held in a single database that can handle all the day-to-day customer transactions and updates, as well as analytical requests – in virtually real-time" (Acker *et al*., 2011, p. 129). This kind of configuration can be highly advantageous to organizations for several reasons. Firstly, there are significant performance improvements in that users can interact and query data that is in memory meaning that response time and calculation performance is greatly improved. Furthermore, this gives users more self-service, flexibility, and access to the information they need, thus enriching their insight. One of the key advantages is that these configurations have a far lower total cost of ownership and storage infrastructure than traditional data warehouse environments (Acker *et al*., 2011).

BI architectures have also started to extend towards service-oriented architecture (SOA); these are principles and methodologies for designing software in a manner that "supports the integration of business as connected and repeatable business services" (Ishaya & Folarin, 2012). This means that different standalone services can be "loosely coupled over distributed systems", yet still remain integrated and interoperable (Ishaya & Folarin, 2012, p. 277-278). Therefore in a BI environment, this architecture is highly appropriate for "agile and flexible applications, application-application integration, high frequency events, [and] real-time data analysis" (Ishaya & Folarin, 2012, p. 278). Although these configurations are still in early stages, they shed light onto where real-time BI architectures are heading.

2.4.4 Interacting with a real-time Business Intelligence system

It is important to understand the technologies that are typically used to display information to users at the presentation layer. In a real-time BI environment, it would be difficult, if not impossible, to make sense of a continuous and voluminous stream of data, without the necessary analytical tools in place.

Analytical tools are supported by visualization techniques that can represent information in a manner that is easy to understand. These visualizations (e.g.: graphs, tables etc) and aggregations are then presented in a single (interactive) display called a dashboard (Negash & Gray, 2003. p. 3192). In essence, the dashboard is the user interface of an executive information system that is designed to display data in a manner that is holistic and easy to understand (Blickle, Hess, Klueckmann, Lees, & Williams, 2010, p. 78). The dashboard is therefore like the physical peak of an iceberg of data. With this, the user is able to analyze copious amounts of information by having a summarized/overview of them available on the dashboard (Raden, 2003, p. 13). Further, it is able to identify "structure, patterns, trends, anomalies, and relationships" and can represent it in a way that is easy to understand (Negash & Gray, 2003, p. 3192). Dashboards make use of KPIs; these are metrics that are used to measure business process performance (Blickle *et al.*, 2010, p. 79). These are normally key areas of performance that measure the current state of the business and which need to be closely monitored by decision makers.

Dashboards typically consist of three layers / views of information. Information can either be "graphical, abstracted data to monitor key performance metrics, summarized dimensional data to analyse the root cause of problems, and detailed operational data that identifies what actions to take to resolve a problem" (Eckerson, 2006, p. 6).

Typically, there are three kinds of dashboards: operational, tactical and strategic (Eckerson, 2006, p. 7). Operational dashboards are used to monitor core operational processes and normally display more real-time data. The emphasis is on monitoring more than it is analysis or management. Tactical dashboards however, emphasize analysis, and are used to track departmental processes and projects. Finally strategic dashboards, which are also known as scorecards, monitor the performance of strategic objectives and are more focused on management than monitoring or analysis.

2.4.5 Real-time Business Intelligence implementation considerations

The enhanced BI architecture may seem clear-cut, but because there are no established best practices and shallow experience for implementation; it is likely to present numerous challenges (Raden, 2003, p. 9), both technological and organizational.

To illustrate some of these challenges, the research will first look at findings taken from two case studies. The first study on Continental Airlines outlined the following considerations for organizations that are planning on moving into real-time BI (Adapted from Watson *et al.,* 2006, p. 13-15).

- It is important to understand that reducing latency requires *technical solutions*, good *business case(s)*, as well as *process change*. As this will require time, it is advised that an *incremental* approach be adopted, whereby it is achieved in steps rather than at once.
- As previously mentioned, it is vital for an organization to *define what 'real-time' means* to them.
- Users need to be *educated* about what real-time BI is and what it can do. Failing to do so may result in a major under-utilization of the system. Prototyping is a commonly used approach for demonstrating the functionalities of a system whereby users are able to engage with (usually an aspect of) the system. In addition to this, change management practices have also been found useful in this context.
- The ETL process should be as *automated* as possible; having little or no human intervention. This process should also be designed so that it is *reusable and flexible*; allowing changes to be made easily.
- It is important to manage strategic and tactical queries so that they can successfully co-exist. It is because of their different characteristics that they need to be designed in a way that allows both to operate in the same environment. For example, strategic decisions involve the analysis of large amounts of data (in order to obtain more breadth across a variety of subject areas) that is normally 'sliced and diced'. Tactical decisions however are more information sensitive; they require faster access to a limited amount of data which requires a faster response time in order to minimize the latency window. This will require technical and capacity planning whereby resources are correctly allocated in order to prioritize tactical queries.

The second case study was conducted on several international retailers, and it demonstrates reasons behind their reluctance to adopt real-time BI (Kilcourse & Rosenblum, 2008). Although this study was conducted on retail industries only, it echoes many of the concerns that have surfaced (Figure 7). Inhibitors include difficulty in calculating ROI, cost of integration, difficulty of integration, lack of confidence, user resistance, poorly defined business processes, as well as working on platforms that are not flexible for change. The same report also indicates that over 50% of retailers were unable to deliver real-time BI;

therefore, it is not surprising that business executives question the ability of new projects to drive return on investment (ROI).

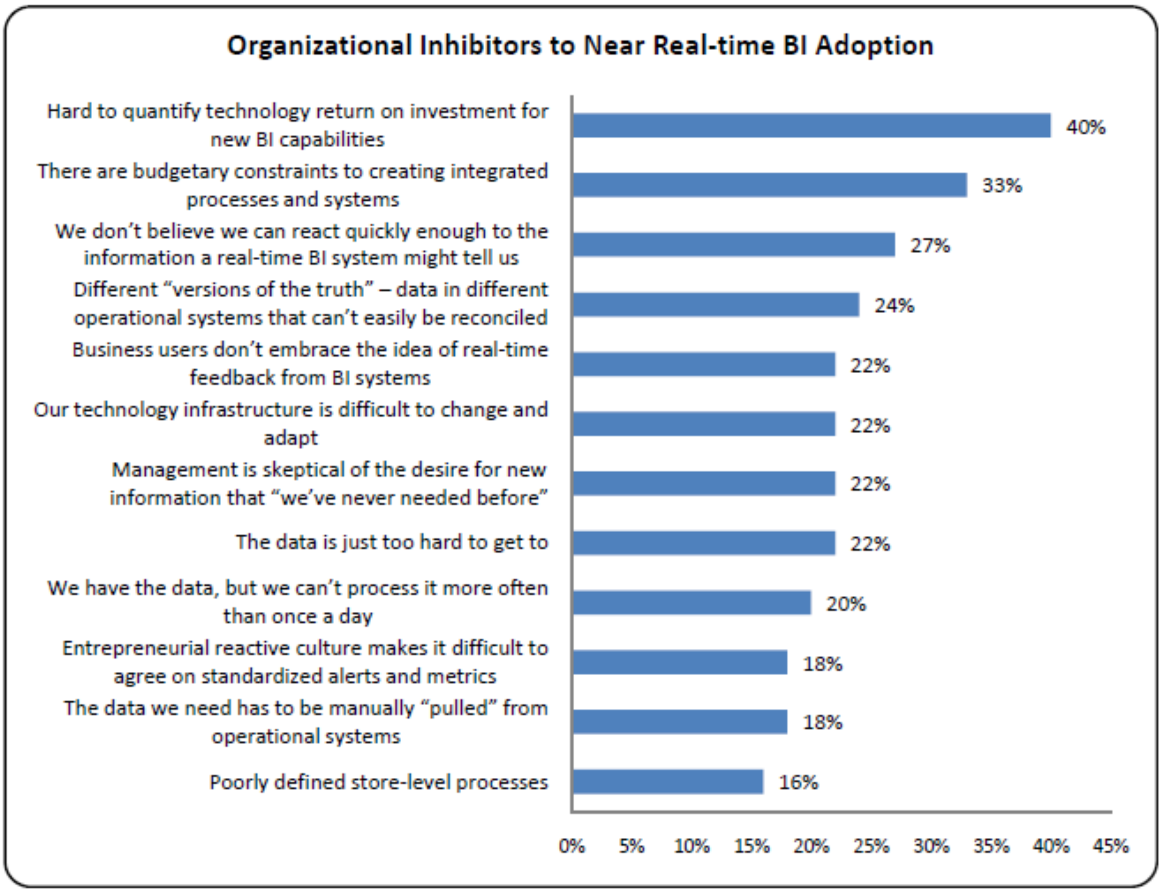

Figure 7 - Inhibitors to RTBI Adoption : Case Study (Kilcourse & Rosenblum, 2008, p. 16)

These findings support many of the considerations that were raised in literature thus far. At the technological level, it is important to first ensure that an organization's systems are fully integrated and consolidated into a central DW; this is key to enabling the architecture (Gangadharan & Swamy, 2004). Organizations may need to acquire new tools and technologies that need to be integrated with the existing architecture (Azvine *et al.*, 2005). Organizations also need to ensure that they have the skills to use and implement these too. Furthermore, there are several different ways in which real-time data can be enabled; organizations need to assess these options and plan for their respective technological configurations (Langseth, 2004).

In many cases, real-time BI also requires some level of business process re-engineering (BPR); this is the "implementation of deliberate and fundamental changes in business processes to achieve breakthrough improvements in performance" (Kettinger & Grover, 1995, p. 111). Findings suggest that, because re-engineering is a complex procedure that involves many factors, "it is essential that change be managed and that balanced attention be paid to all identified factors, including those that are more contextual (e.g., management support and technological competence) as well as factors that pertain directly to the conduct of the project (e.g., project management and process delineation)" (Grover, Jeung, Kettinger, & Teng, 1995, p. 110). In addition, BPR was recently rated the fifth highest management issue in the United States, second in Europe, and seventh in Asia/Australia (Luftman & Ben-Zvi, 2010, p. 6)

Organizations also need to decide whether they are going to build or buy real-time BI solutions (Bugajski, 2010). Bugajski (2010) advises that there should be a good match between the solutions capabilities and the organization's business information requirements. In doing this, they need to also define their own expectations regarding data latency (how real-time the data should be); this will depend on the business' requirements. Organizations also need to be aware that training may be required to both demonstrate and teach users about the new system.

There are also several financial implications that need to be considered (Negash & Gray, 2003). Organizations implementing such systems may encounter major hardware as well as software costs. After having acquired these, a large portion of the expense is attributed to implementation (including training). In addition, organizations will need to budget for various personnel costs, including consultants, IT support and analytical users. Further, Agrawal (2009) suggests that the current adoption of real-time BI is hindered because of a lack of clarity surrounding the underlying technical components as well as the significant costs associated. As such, Schneider (2006) stresses that because low latency costs money, the business decisions to be made with reducing latency must justify the investment.

BI, like many IT projects, provides mainly intangible benefits which are not only hard to quantify, but are also incompatible with traditional financial measures such as ROI (Soh & Markus, 1995). For example, intangible benefits could result from improved business processes or greater business knowledge. It is not uncommon for an IT initiative's value, especially with real-time BI, to become embedded in a business process where, unless the evaluation technique can measure the system accurately, "managers may only see the resulting system maintenance costs and no real added business value" (Gibson, Arnott, & Jagielska, 2004, p. 297).

With these considerations in mind, organizations should not rush into implementing systems of this size before actually identifying areas where real-time analytics is applicable. Clearly, not all organizations demand low latency data (Hackathorn, 2002, p. 8). Bugajski (2010) stresses that it is vital to first understand the business requirements and challenges not only to arrive at an optimal decision about the proposed system, but to ensure a right fit between business and IT so that they see eye-to-eye in the investment. In evaluating where real-time BI can be beneficial, Raden (2003, p. 8) suggests that situations "where the organization's response to a set of variables can be well defined, automatic, and reflexive", is where real-time analytics can offer the most value. Where this process can be automated, and a certain degree of flexibility allowed, is where the ideal real-time analytical circumstances exist. Thus, the discovery of a business problem and/or opportunity, which can be addressed by real-time analytics, should be taken as the first step (Hackathorn, 2002, p. 8). Effective achievement of this, Bugajski believes, will ensure a match between the system's capabilities and a business's information requirements.

2.5 Real-time Business Intelligence Systems in Practice

This section serves to demonstrate cases of organizations that have applied real-time BI systems, and as a result, have managed to leverage value from their investment. Because real-time analytics is not applicable in every context (Hackathorn, 2002), the intention here is to better understand to which environments real-time analytics is applicable. Doing so will also help to conceptualize the business requirements that are driving this technology.

2.5.1 Case Study: Continental Airlines

A Continental Airlines case study, by Watson *et al.* (2006), reveals how the need for a real-time BI system came about, and how it was utilized to achieve numerous strategy-oriented benefits. After having completed a major business strategy, aimed at improving various performance aspects of their organization, Continental had a further strategy in mind. They wanted to position themselves as being their customers' favorite airline through the provision of superior customer service; particularly with their high-end customers. As such, a DW was built that could provide quick access to key information about the business as well as its customers. It was soon realized however, that the new strategy required more "real-time, actionable information to support decision making and business processes" (Watson *et al.*, 2006, p. 5).

Of the various real-time applications that were developed; the Flight Management Dashboard is particularly noteworthy. The dashboard has interactive graphical displays which are "intended to help operations staff quickly identify issues" and then find "ways to improve customer satisfaction and airline profitability" (Watson *et al.*, 2006, p. 6). For example, the dashboard can display where gate connection problems are likely to occur, whilst concurrently identifying where high-end customers are likely to be. Equipped with this information, staff can proactively be sent out to address a potential problem before it even occurs. Another feature of the dashboard allows Continental to keep flights on-time. It does this by displaying the volume of traffic and number of late flights in such a way that "staff can anticipate where services [will] need to be expedited" (Watson *et al.*, 2006, p. 7) proactively. In addition, users are able to view pie charts that categorize flights into degrees of lateness, with which; a further drill-down can be performed to access individual flight information.

Another useful feature of the system is its automated alerts capabilities. When the system is unable to perform an automated process, and requires human intervention, an alert is sent out to a member of staff. The member of staff is then able to address the issue as the notification is received.

2.5.2 Case Study: Haggen Inc.

Haggen, a grocery chain in the United States of America, was in need of a system that could respond to inventory-shortages proactively as they occurred, rather than after both the stock and prospective customers had diminished (Fogarty, 2008, p. 1). Haggen had been using an outdated system which was programmed to serve up summary files and log data at 3am. These were then pulled into a data warehouse at 6am from all the various stores. As a result, the business was only able to access the previous day's activity at 9am which significantly decreased the value of the information.

In response to this, a real-time data warehouse was built with a "trickle-feed of data [which comes] in all the time from the [various] stores", and which can be accessed "within fractions of a second after [a] transaction" (Fogarty, 2008, p. 1) has taken place. CEO Harrison Lewis explains that having business visibility throughout the day allows Haggen to respond faster and to "take advantage of a good situation or minimize the impact of a bad one" (Fogarty, 2008, p. 1). The following case study illustrates a similar need that drove Moulton Logistics Management towards the implementation of a real-time BI system.

2.5.3 Case Study: Moulton Logistics Management

Moulton Logistics Management is a company that specializes in product fulfillment (the entire process – from production to delivery – of a product), as well as distribution for retail and marketing industries. Moulton realized that, in order for it to be effective, it needed to offer its marketing clients the ability to "perform real-time analytics on every aspect of [their] marketing campaign[s]" so that they can take "immediate action based on the findings" (Felix, 2009, p. 25). Thus, "instead of waiting for retail sales and return figures to trickle back to the marketer months later" (Felix, 2009, p. 25), users need instant access to the bottom line figure of a marketing campaign. Moulton was able to successfully achieve this requirement through the implementation of a real-time BI system.

2.5.4 Case Study: Strategy.com and Overstock.com

Strategy.com and Overstock.com are good examples of e-commerce companies that were able to leverage real-time analytics. Strategy.com, which for unrelated reasons is no longer in business, focused on delivering "near real-time, personalized news and information" (from financial markets to sports events) to their customers (Hackathorn, 2002, p. 16). Through the effective utilization of real-time data, they were able to offer proactive alerting and reporting services to the various news streams.

Overstock.com, an online retailer, wanted to "enable a real-time, single view of [their] customer[s] to better understand purchasing habits, refine marketing efforts, and more effectively drive business to its website" (Oracle, 2010, p. 12). Furthermore, as an online retailer; it had zero tolerance for downtime. As such, a real-time BI system was an ideal candidate to satisfy these requirements; whereby, through the use of customer behavior and purchase history; it could target marketing campaigns in real-time.

In light of both strategies, it is clear that extending real-time BI to the e-commerce domain is particularly useful. In addition to the case studies, Raden (2003) demonstrates how real-time

BI is driving several analytical processes that have been or are being incorporated in major business functions.

2.5.5 Some Real-time BI Analytics

The concept of *dynamic pricing* refers to the adjustment of prices, at or near the point of sale, in order to maximize profits (Raden, 2003, p. 10). In other words, it is used to make the best possible pricing decision, based on the circumstance (e.g.: frequency of customer) at the moment of sale. In order to make this possible, there is a need for rich historical and contextual information (sourced from a data warehouse), along with an instantaneous stream of pricing schedules and evaluation criteria, throughout the normal course of the business (Raden, 2003, p. 10).

Yield management, a different type of dynamic pricing, is used to maximize revenue “in service industries that are limited by capacity, such as airlines and the hospitality industry” (Raden, 2003, p. 11). Because there is typically a fixed inventory (e.g.: number of seats on a flight) and a fairly elastic pricing scheme; yield management is reliant on demand forecasting. It is generally understood that because demand is seasonal, there is a need to keep historical data. Based on a complex algorithm, demand forecasting accounts for “passenger demand patterns, cancellations, group reservations, cargo load, and other estimates” (Raden, 2003, p. 11). Furthermore, because this is a continuous process, each instance of a transaction requires the re-adjustment of the demand forecast in order to actively adjust the price.

In addition, *rules engines/automated attendants* are complemented by real-time analytics; where the environment is typically a closed-loop one (Raden, 2003, p. 12). Through the application of business-rules, rules engines and automated attendants can be used to formulate and carry out self-made decisions. Similarly, real-time BI makes automated/semi-automated learning of operational data possible, which allows for *what-if analysis* to be conducted (Azvine, Cui, Majeed, & Spott, 2007, p. 157). These capabilities have been particularly effective in the field of *fraud detection*. With the ability to model a spending pattern through the consolidation of transaction history, fraudulent activity can be identified when transactions “fall outside the range of expected patterns” (Raden, 2003, p. 11). When this occurs, organizations are able to act proactively and take corrective action before any serious damage is incurred.

Having considered various case studies as well as application areas for analytics, it is evident that real-time BI is applicable to a wide range of business areas. In doing so, numerous business requirements that are driving real-time BI adoption are beginning to surface. Ultimately, these requirements can be translated into business benefits that may help organizations in justifying a real-time BI investment.

2.6 Benefits & Benefits-Measurement of Real-time Business Intelligence Systems

Thus far, various benefits and applications areas of real-time BI have been demonstrated in numerous studies. In order to better conceptualize these, there is a need to consolidate them into a more summarized view. As such, Seufert and Schiefer (2005, p. 923) propose seven groupings of real-time BI value:

- "**Real-time business information**

  Real-time BI systems provide access to data with minimal latency thus improving visibility and accuracy of business performance indicators.
- **Optimized business processes**

  Real-time analytics have made it possible to better optimize the internal and external business environment through the effective use of S&R. In addition, Sahay and Ranjan (2008, p. 43) refer to a particular study which identified process enhancement as the largest benefit brought about by real-time BI.
- **Automatic discovery of situations and exceptions**

  The use of S&R capabilities can be further leveraged to support the continual discovery of opportunities and exceptions. This, for example, has been utilized for fraud detection by identifying suspicious behavior and implementing corrective action proactively.
- **Proactive responses**

  The ability to continuously analyze customers, competitors and business partners allows for the business environment to be adapted and optimized on a proactive basis.
- **Generating more accurate forecasts**

Having access to both current and historical data allows for intelligent forecasts to be conducted, which for example, have been used to optimize production plans based on current demand levels.

- **Integrating internal and external source systems**
  S&R systems are also able to "correlate and merge event streams from the internal and external business environment". In other words, when a business event occurs, it will be identified by the S&R system and logged onto its respective repository.
- **Less integration effort**"
  S&R systems also make integration significantly easier than typical data warehouse solutions.

The justification of an IT investment needs, however, to go beyond the realization of benefits. Consequently, this presents a different challenge altogether.

2.6.1 The Measurement of Benefits

Typically, before an investment can be considered, it needs to demonstrate financial value (Lönnqvist & Pirttimäki, 2006). The problem is that if a benefit cannot be measured, it is likely to compromise its value proposition (Reiss, Anthony, Chapman, Leigh, Pyne, & Rayner, 2006). Gibson *et al.* (2004) explain that technologies that do not provide a quick impact to a business' bottom line are generally not deemed prudent investments. Normally, a potential investment is thoroughly evaluated for perceived benefits and value for money; management however, is reluctant to sign-off on a project unless its benefits are clearly demonstrated.

A study by Lönnqvist and Pirttimäki (2006), found that there are two primary reasons why measurement is important. Firstly, in order to prove that an IT project is worth the investment, it needs to be measured. This is because at the executive level, where investments are typically approved, there is a need to demonstrate tangible benefits. The second purpose for measurement is to aid in the management of the investment process. In other words, it is a way to ensure that IT products are satisfying user requirements and that the process is being done efficiently.

The assessment of value comes down to two things; the cost of the investment and the benefits of its application (Lönnqvist & Pirttimäki, 2006, p. 354). A simple total cost of ownership (TCO) analysis can be applied to the former requirement with relative ease. The latter (measurement of benefits) however, is the more difficult task. This is because "many of the effects that BI is assumed to create consist primarily of nonfinancial, and even intangible, benefits such as improved quality or timeliness of information" (Lönnqvist & Pirttimäki, 2006, p. 354). Intangible benefits are thus incompatible with traditional means of measuring investment through financial indicators like ROI, return on assets, and ratio of expenses to income (Soh & Markus, 1995, p. 36). Because intangible assets are difficult and sometimes impossible to quantify, they are often overlooked sources of business value (Gibson *et al.*, 2004). Interestingly however, Gibson *et al.* (2004) also cite a study by Surmacz (2004) which states that in a survey of 540 IT professionals, users, and consultants, it was found that intangible benefits outweighed a large portion of the tangible benefits, including ROI and cost savings.

The inability to realize this value has led to a phenomenon called the 'IT catch 22'. This is a situation in which executives understand that, for competitive reasons, an investment in IT is necessary, yet "financially they are faced with difficulties in finding sufficient justification" (Arnott & Gibson, 2005, p. 2). In light of this, there has been a shift in the IT evaluation paradigm, from financially based methods to techniques that accommodate other issues, such as intangible benefits (Gibson *et al.*, 2004). None of these, however, are regarded as best practice (Elbashir, Collier, & Davern, 2008). Before these can be explored, it is important to first define several terms that are used in the evaluation of IT.

Firstly, the term *value* is used to refer to how useful something is, as perceived by its evaluator. As such, it is "is likely to vary depending on the subjective appreciation and need of the person(s)" who is/are evaluating it (Lönnqvist & Pirttimäki, 2006, p. 354). In this context, it is assumed that value is assessed from the perspective of the organization. Secondly, a distinction is drawn between *objectives* and *benefits*. Investment objectives, as agreed upon by the stakeholders, are the general goals and aims of the investment (Ward, Daniel, & Peppard, 2008, p. 6). In contrast, "benefits are [the] advantages provided to specific groups or individuals as a result of meeting the overall objectives" (Ward *et al.*, 2008, p. 6).

Several methods for the measurement of intangible benefits exist, each of which holds some credit. Some methods attempt to overcome the incompatibility of financial measures whilst others attempt to attach financial value to intangible benefits and expected outcomes.

2.6.1.1 Business Cases

Ward *et al.* (2008) advocate that business cases can be powerful tools for justifying IT investments if applied correctly. Typically, a business case will include a cost-benefit analysis as well as a benefits realization plan. The creation of a benefits realization plan also serves a basis for which a review of proposed benefits can be conducted. As such, it is believed that this can ensure executive-level commitment by means of better demonstrating investment benefits. Business cases however, have frequently fallen short in the ability to attach value to qualitative benefits, and have also been criticized for overstating benefits to ensure approval. For this reason, Ward *et al.* (2008, p.5) propose a framework (Figure 8) for building better business cases.

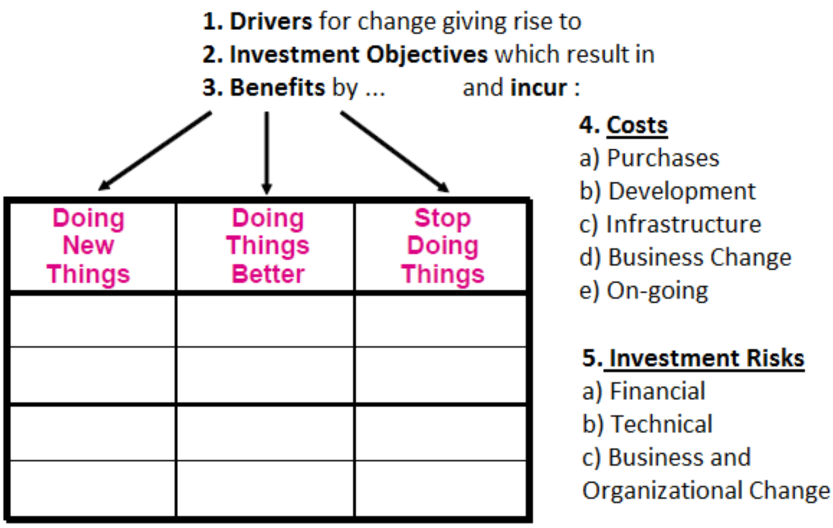

Figure 8 - The complete business case (Ward *et al.*, 2008, p. 13)

First, organizations need to list the *business drivers*; these are the issues facing the organization that can be addressed through implementation of the proposed technology. In addition it should state the objectives that define, on a high-level, how those business drivers will be achieved. Secondly, it is important to identify the expected benefits that will be realized once the objectives have been met. After being listed, the benefits need to be supplemented with information regarding how they will be measured, and who will be their owner. Assigning ownership to a benefit is an important component because it ensures that they are realized. In addition the benefits should be structured according to two factors: the business change required to achieve the benefit, and how that benefit is categorized according to how much is known about it. The latter factor is the explicit value of each benefit; this can be categorized as financial, quantifiable, measurable, or observable. Ward *et al.* (2008, p. 8) term these categories as the *degree of explicitness*; they are "based on the ability to assign value to the benefit from information that is known already or can be determined before the investment is made".

Observable benefits are those that are measured by opinion; these are typically qualitative and intangible in nature. When these are listed, they should be supplemented with a statement of the criteria that will be used to evaluate their achievement. Although these types of benefits are unlikely to have significant leverage behind an investment case, they should not be omitted. *Measurable benefits* are those for which an identified measure is already known or can be put in place. Furthermore, this allows current performance of the operation to act as the baseline prior to the investment. It is however not possible to estimate how much performance will improve by after the technology is in place. *Quantifiable benefits* have already known measures in place too, but unlike measurable benefits, the size of the benefit can be predicted reliably by forecasting the future. Finally, there are *financial benefits* which play a key role in the investment because they can be expressed in financial terms. This means that there is sufficient evidence to demonstrate how the value will be achieved. They should therefore be the result of applying a financial formula, which in turn, demonstrates the overall financial value of the investment as well as the ROI.

In addition, the business case should also include all of the costs, as well as an assessment of the possible risks. Although IT costs are relatively easy to calculate, those associated with making organizational changes are more difficult.

2.6.1.2 The Balanced Scorecard

Another common method of evaluating the performance of a project is by means of a balanced scorecard. This approach aims at evaluating performance from the customer, financial, internal business processes, and innovation and learning perspective (Kaplan & Norton, 2008). Ultimately, the balanced scorecard is concerned with choosing measures and targets. It is considered effective not only because it considers multiple perspectives, but that it can be used in projects that measure both tangible and intangible benefits. This approach has been extended to a real-time BI analytics (for risk-management) framework which proposes that relevant performance quantity areas are first identified (Azvine *et al.*, 2007, p. 157). Because these are likely to vary in context, the balanced scorecard allows for metrics to be selected based on an organization's strategy. Subsequently, the performance metrics then provide a framework for which strategic measurement and management can take place. There are however, no guidelines on how to combine performance measures. It also does not provide a bottom line score, or a unified view with clear recommendations, as it is simply a list of metrics. Furthermore, because it considers both financial and non-financial aspects, it is particularly difficult to select right measures. Additionally, because the selection and definition of these measures is subjective, there is room for error.

2.6.1.3 Business Process Performance Measures

A different stream of BI evaluation approaches, aimed at realizing value at the process-level, could be more applicable to real-time analytics. Elbashir *et al.* (2008) propose that, because BI impacts on process performance and organizational performance, studying benefits at the process-level could provide insight as to how that value is created. Using Porter's value-chain analytics framework, which is used to identify the business activities that are supported by BI, Elbashir *et al.* (2008, p. 138) carried out a survey on 212 organizations. The results were grouped into organizational measures and business process measures. The business process measures included supplier/partner relationship benefits, internal process benefits, and customer benefits (Elbashir *et al.*, 2008, p. 145). The organizational measures are used as evaluation tools in assessing whether performance benefits have been achieved whereas process-level benefits are diagnostic tools used to evaluate why benefits have/have not been realized. This too however has been criticized for being prone to bias due to the fact that the study relies on subjective (perception-based) measures.

Alternatively, Soh and Markus (1995) propose a synthesis of both process and variant theories which aim to uncover the relationship between IT investments and business value. Unlike typical financial-based organizational performance measures, Soh and Markus (1995, p. 36) maintain that performance is a multi-dimensional construct. Figure 9 presents the proposed process theory synthesis model. In short, it is believed that if organizations spend money on IT; they are able to obtain IT Assets. This conversion process however, is dependent on how effectively the IT management process is conducted. The IT management process is typically reliant on the formulation of IT strategy, selection of appropriate organizational structures for the execution of IT strategy, selection of the right IT projects, and effective management of the projects (Soh & Markus, 1995, p. 38). Consequently, if IT Assets can be combined with the process of appropriate use, they can lead to IT Impacts. Appropriate use means that "some threshold level of IT must be achieved before an impact can be observed" (Soh & Markus, 1995, p. 38). Finally, if not adversely affected by the competitive process; IT Impacts can lead to improved organizational performance.

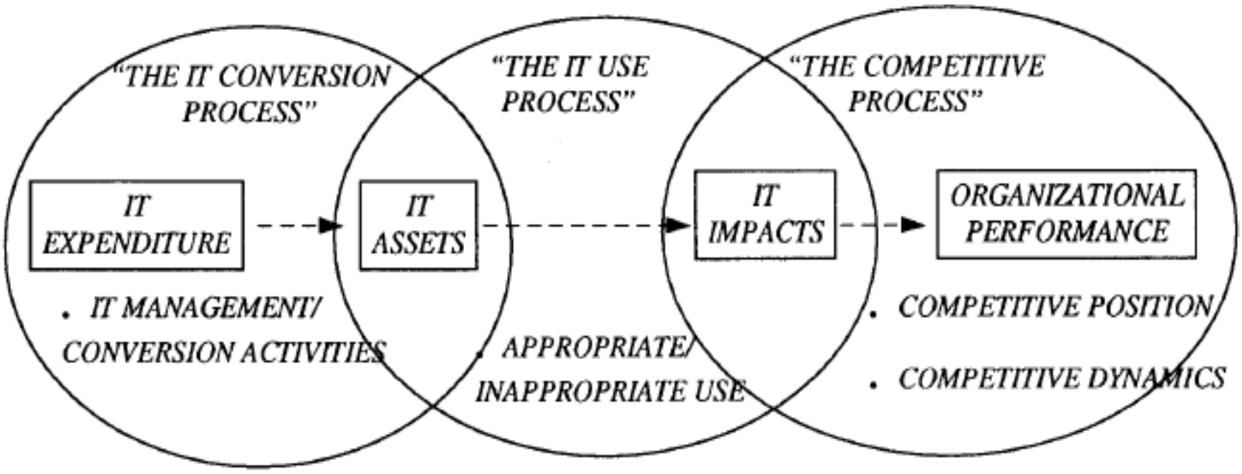

Figure 9 - How IT Creates Business Value: A Process Theory (Soh & Markus, 1995, p. 37)

2.6.2 Overview of Benefits Measurement

As discussed, the justification of an IT investment rests on how effectively it can be demonstrated to executive managers for approval. In order to do this, the measurement of both tangible and intangible benefits is necessary in proposing a strong business case. Although benefits measurement techniques attempt to address the challenge of measuring benefits, especially those of an intangible nature; each has its limitations and there is still no standard method. Despite the criticisms however, the bottom line is that each method provides an organized way in which a cost/benefit analysis can be carried out. Whether financially-based or not, it can be used as a framework to conceive investment proposals in a logical and structured manner.

2.6.3 BI Maturity Models

BI maturity assessment models are useful techniques used to describe, explain, and evaluate the growth phases of a BI system (Rajterič, 2010, p. 49). Maturity models are useful in this regard (Rajterič, 2010, p. 49) because "the influence of faster access to better and broader information on business decisions is not easily identified … [and it is] even more difficult to assess and/or measure this influence on business results as a whole". It is important to state that this model assumes that some sort of BI infrastructure is already in place and would thus not be appropriate for a completely new BI investment. For organizations that already have BI however, and are considering evolving their system, to real-time BI in this case, can certainly find value from this.

The basic concept of maturity models is that "things change over time and most of these changes can be predicted and regulated" (Rajterič, 2010, p. 49). Each level of maturity has key process areas that are typical of the particular level. Essentially, key process areas "represent phases which need to be completed by the organization in order to achieve a certain level of maturity" (Rajterič, 2010, p. 49).

At their core however, these models help organizations understand where they are, how they can improve, and answers the questions: Where in the organization is most of the reporting and analysis done? Who is using business reports, analysis and success indicators? What drives BI in the organization? What strategies for developing BI are in use? What business value does BI bring? (Rajterič, 2010, p. 50). It is also important to state that, a key factor in achieving business value from BI is realizing that an organization's level of BI maturity should try to match the maturity of the organization itself (Rajterič, 2010, p. 48). There are however, various different models available on the market. The two maturity models that will be discussed herein are the Business Information Maturity Model and TDWI's Business Intelligence Maturity Model.

The former model, suggested by Williams and Williams (2007) is focused on increasing the importance of BI and uses three success factors for BI, alignment and governance, leverage, and delivery. There are three main levels of this maturity model. The first level describes organizations that use a DW for faster access to data but in an unstructured way. Furthermore, information demands are focused on the "what" aspects. In the second level, organizations realize that they need to define the role of information in order to leverage the investment. Users not only want information on the "what" but also in terms of "who", "when", and "where". The third level signifies that all parts of the organization are involved and integrated. Here, the organization "recognizes the fact that the decision processes, before the introduction of the in time information, are not optimal and it tries to replace them with the new decision processes" (Rajterič, 2010, p. 51). Therefore, organizations try to find out "how" processes can be improved if the information is available.

Wayne Eckerson first proposed the idea of The Data Warehouse Institute (TDWI) model in 2004; this however, was later redeveloped for the BI domain. TDWI's BI maturity model is particularly useful in that it focuses on the technical aspects of maturity assessment. Here, maturity is evaluated through eight areas: scope, sponsorship, funding, value, architecture, data, development, and delivery. These eight areas are then graded with a five grade scale that includes infant, child, teenager, adult, and sage (Eckerson, 2009).

The *infant* stage begins at the prenatal stage where there are only operational systems with in-built reporting and a DW does not exist. Reports are static and limited to the individual system. Organizations move out of the prenatal stage into the infant phase when numerous partial data sources, such as spreadsheets and desktop databases, are used instead of a regional DW. Each contains a set of standards, metrics and rules but there is typically little-to-no correlation between them. As such, organizations can have conflicting views of information with the effect of compromising the decision-making process and failing to provide a consistent view across all events in a company.

In the *child* stage, information is gathered at a departmental level where interactive reporting tools are normally first implemented. Furthermore, regional DWs are built at this level but they are still not integrated across the departments, and do not yet have a common set of rules and definitions.

By the *teenager* stage, organizations understand the importance of using standardized development methodologies and start to use common data models and platforms across the business. More importantly however, this is the stage where organizations recognize the importance of consolidating regional DWs into a centralized DW, thus enabling enterprise-wide analysis and linking departments. It is here where organizations may implement dashboards for different groups of users.

In the *adult* stages of maturity, BI is recognized as the core IT system that drives the daily operations of the company. The core characteristics of adulthood include "centralized management of BI data sources, common architecture of the data warehouse, fully loaded with data, flexible and layered, delivery in time, predictive analysis, performance management, and centralized management" (Rajterič, 2010, p. 53). Here, KPIs are used to compare the actual business performance with the high-level strategic goals in real-time, and other complex analytical tools are beginning to be used. Furthermore, the DW is dynamic in that it allows adjustments to be made for new business needs with ease and flexibility.

Finally, at the *Sage* level, developers are starting to leverage data services and BI systems into new solutions, such as technical and business services. Here development has moved back to the organizational units and it is common for service oriented architecture (SOA) architecture to be used.

In light of this, maturity models are powerful tools that can help organizations understand where they are, and how to get where they want to be. As such, those who want to pursue real-time BI endeavors should first take the time to understand where they are in terms of maturity.

2.7 Summary of Literature Review

The first section examined why organizations need BI, how it is used, the components behind its architecture, and also its shortcomings. In summary, the main goal of BI is to help organizations make decisions by consolidating disparate and distributed sources of information into a single repository from which analysis can be conducted. While BI systems can be configured in multiple ways, their architecture shares similar principles. In essence, they integrate and consolidate business systems into a central storage place, usually a DW, which is then queried using BI analysis tools. BI data is only as current as the last DW update. However, due to the nature of batch updates and ETL processes; this means that it mainly shows a historic view of the organization and allows for reactive responses to situations. Moreover, BI does not provide the ability to link action back into business processes and cannot support the seamless transition of information into action; an ever increasing need in the current business environment where time-sensitive decisions are made daily.

The second section investigated why organizations tend to move towards real-time BI. Reasons included demand for quick access to key information, the need to react faster to business events, to take proactive responses, to see the current state of the business in relation to business objectives, and the ability to automatically adapt to the changing business environment.

The third section looked at various elements of real-time BI, the components behind its architecture, how users interact with it, and various implementation challenges and considerations. There are several requirements to enabling a real-time BI architecture; the fundamentals include a continuous integration of data, access to historic data, and analytical environments with analysis and decision engines that are capable of recommending or even taking decisions. This is therefore likely to require new tools and technologies. Users typically interact with these systems through dashboards which can be configured for strategic, tactical, and operational users with KPIs to monitor context-specific indicators of performance. Some of the implementation challenges include the need to change and re-engineer business processes, enabling a continuous and enterprise-wide integration of data, acquisition and implementation of new tools and technologies, user training, and the difficulty in calculating the ROI in order to justify the high costs associated with real-time BI.

The fourth section analyzed several case studies of organizations that have applied real-time BI systems, as well as several types of analytics. Case studies included Continental Airlines (transport), Haggen Inc. (retail), Moulton (logistics), and strategy.com and overstock.com (e-commerce). All of the case studies supported the above-mentioned findings surrounding why organizations move into real-time BI. Further, it was found that real-time BI tends to be driven out of strategic objectives and is usually used to improve performance at operational levels of the organization. Some analytics included dynamic pricing & yield management, and the application of sense & respond tools and rules engines which are typical in fraud detection.

The fifth section first explored the benefits of real-time BI, and then looked at various frameworks that can assist in the measuring of benefits for the purpose of justifying real-time BI as an investment. Benefits included access to real-time business information with minimal latency, optimized business processes, automatic discovery of situations and exceptions, proactive responses, accurate forecasting, and seamless integration of internal and external data sources. Furthermore, benefits measurements frameworks included business cases, balanced scorecards, BI maturity models, and business process performance measures; namely, Porter's value-chain analytics framework (Elbashir *et al.,* 2008) and Soh and Markus' (1995) Process Theory.

In light of this, there is enough literature to support the objectives that have been set out in this research. Furthermore, findings suggest that because the need for real-time BI is growing and its benefits are becoming more widespread, more organizations will look to implement it given the nature of the business environment. This however, is coupled with a lack of understanding surrounding many technical aspects, a host of considerations, and high costs associated with its implementation. Furthermore, the measurement of benefits is a difficult process, but is also crucial to building a suitable justification for its investment. As such, it is believed that the proposed study certainly warrants research.

Chapter 3 – Research Design

Chapter Three presents the methods and procedures adopted in this study. The chapter looks at the proposed research questions, research philosophy, research approach, research strategy, timeline, data / variables, sampling strategy, instrument design, data collection, data analysis, and the proposed contribution.

3.1 Research Questions

1. What are the challenges and considerations, both technological and organizational, which need to be addressed when planning for, or moving into real-time Business Intelligence?
2. What are the application areas and related analytics of real-time BI, and how are they enabled in this environment?
3. What goes into the planning and approval of a real-time business intelligence investment and how is it justified?
4. How does the introduction of real-time business intelligence affect its users, and how does it influence decision-making at different levels of the organization?

This research has four primary research questions. Firstly, to understand the challenges and considerations, of both a technological and organizational nature, which are encountered when implementing real-time BI. Secondly, to identify application areas and analytics and understand how they are enabled in a real-time BI environment. The third question regarding planning for real-time BI is somewhat open-ended. When interviewing, various sub-questions were used (Appendix A) as a prompt-sheet, so as to ensure that the necessary areas were covered. As the interviews are semi-structured however, the question was left as open-to-discussion as possible, but occasionally required support and guidance from the sub-questions. Finally, the question surrounding the users of the system looked at data requirements, adoption issues, as well as how decision-making is affected at different levels of the organization.

3.2 Research Philosophy

Given the nature of the real-time BI field, which is still in its developing stages (particularly in literature), the research followed an interpretive form of investigation. The selection of this paradigm was deemed appropriate as it intends to create a greater understanding of the phenomenon of real-time BI and its pre-adoption considerations. According to Klein and Myers (1999, p. 69), the knowledge of a reality can be described as a culmination of shared meaning and/or interpretation amongst individuals.

> *"… it does not define dependent and independent variables, but focuses on the full complexity of human sense making as the situation emerges; it attempts to understand phenomena through the meanings that people assign to them"*

Interpretive studies can be carried out in a qualitative or quantitative manner; these can also be combined. This research chose to follow a qualitative route in order to bring out a full and in-depth understanding of the real-time BI phenomenon (Orlikowski & Baroudi, 1991; Walsham, 1995). In doing so, it was able to garner views and perceptions of the phenomenon, and subsequently discover new insight and support existing literature.

3.2.1 Research Approach

Qualitative research can follow either an inductive or deductive reasoning approach. Given the nature of the research task, the complexity of the phenomenon, as well as the paucity of literature, an inductive approach offers the most appropriate protocol. The purpose of an inductive approach, Thomas (2006, p. 2) explains, is to "allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies". Unlike deductive research which typically follows a methodology, inductive reasoning first seeks to flesh out data from which a model and/or theory is subsequently built upon.

Babbie and Mouton (2007) explain that, when conducting such research, it is important to first immerse in the natural setting of the particular subject. Thus, this research has investigated the general real-time BI field, various considerations, benefits, application areas, and IT evaluation methods. After careful review of both the literature and interview data, a conceptual model was derived in order to illustrate the observations in the form of a pre-adoption guideline for the justification of a real-time BI investment.

3.3 Research Strategy

The primary goal of this research is to enhance the understanding of the real-time BI field with emphasis on pre-adoption considerations. Figure 10 outlines the research strategy that was followed (Adapted from Gibson, Arnott & Jagielska, 2004).

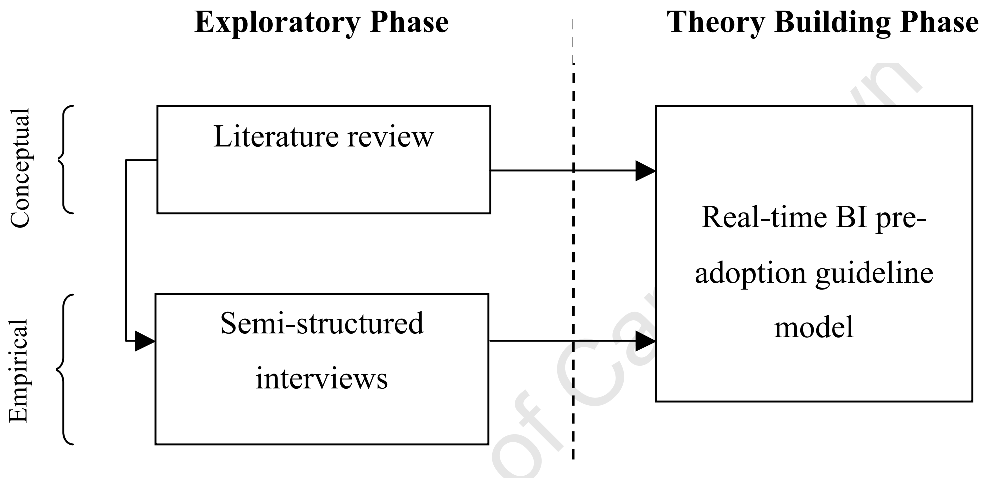

Figure 10 - Research Strategy

In light of this, the research comprised of both conceptual and empirical components. The conceptual section was important for the exploratory stages of the real-time BI sphere and IT evaluation methods. More specifically, it explored what real-time BI is, where it has been applied, what benefits it brought about, and what issues surround its adoption.

The empirical phase is reliant on observation in the form of in-depth semi-structured interviews. In addition, the research aimed to obtain other sources of information, such as documentation on the business cases and minutes. These however, could not be obtained due to reasons of confidentiality. After both components were completed and the necessary data gathered, it was consolidated during the theory building phase. Finally, the theory building phase aimed to construct a conceptual model that ties together conceptual and empirical observations in a descriptive manner for the purpose of facilitating real-time BI justification.

3.4 Timeline

One of the key limitations of this research was the limited time in which to complete it for a Masters degree. Therefore, a cross-sectional time-frame was deemed as the most appropriate temporal method. As such, the study collected data once over a period of time. It is likely that the perception and knowledge of people may change over time (Younghwa, Kenneth, & Kai, 2003) and this certainly is a disadvantage to the research. However, it opens an opportunity for it to be tested and furthered in future work.

3.5 Data / Variables

Following from the research strategy, the choice of data that was necessary for the research is discussed. The type of information required was perceptions of organizations that have or are deploying real-time BI systems. More specifically, the research aimed to uncover the experience and opinion of the individuals that were involved in the process, both from a technical and business perspective. In order to do this, feedback was obtained through interviews. The questions were applied in such a way so as to drive the intended direction of the interview towards a deeper understanding of the phenomenon.

3.6 Sampling Strategy

The targeted population included organizations that have or were in the process of implementing a real-time BI system. The reason for this choice is that the type of questions revolved around the activities and decisions that took place prior to implementation, as well as after. In doing this however, the researcher was careful to distinguish between organizations who have already implemented real-time BI from those who were in the process of implementing. Although both types are of interest to this study, those who are in the process of implementing were regarded as having the most valuable information to offer and it was important to draw all relevant facts out of them in interviews.

Within these organizations, it was important to purposively seek participants that had witnessed or were involved in the phenomenon under investigation who would be appropriate candidates for the study. IT staff, including those responsible for BI and a BI competency centre, end-users, and strategic personnel involved in the approval of IT projects were potential targets for the interview. End-users included those on strategic, tactical, and operational levels of the organization because they were likely to provide different responses about BI's use. Here, participant factors such as gender and race were not considered necessary for the study and were therefore not recorded.

In order to obtain a more generalized view, organizations from a variety of different industries were targeted. Furthermore, within those organizations, the research remained open to consider the perspectives of different divisions; provided real-time BI existed in more than one business area. Targeted industries included, but were not limited to, those in the IT, financial, transport, retail, and energy fields as these tended to be early users of real-time BI systems.

The research target aimed to attain between five and eight participant organizations. As a preliminary sampling scheme, convenience sampling was applied. This involved the selection of organizations which were most accessible. The research also included non-probability purposive sampling where the sampling is confined to specific target groups (Cavana, Delahaye, & Sekaran, 2001). This includes participants who can provide the required information or because they conform to the research criteria. This type of sampling design can be exercised in a variety of ways as there are various types of purposeful sampling. In addition, "typical case sampling" was also considered; this involves taking a sample that is considered typical for the particular phenomenon. However, in order to add more depth to the research, different perspectives were also valued. Throughout the process, opportunistic / snowball sampling was applied as the research proceeded, in which, unexpected new leads were pursued, provided they held research value.

Although the sample is somewhat low, it is certainly not in breach of achieving generalizability. Interpretive and exploratory research is typically less concerned with obtaining statistically accurate samples, but rather to "get a handle" on a situation/phenomenon (Cavana *et al.,* 2001). Furthermore, as stated, the research aimed to obtain the perceptions of a variety of industries. It is also important to note that interpretive research opens the door for future research to test its validity and generalizability (Lee & Baskerville, 2003). In light of this, the researcher is of the opinion that the research achieved its quota for generalizability, and has provided sufficient justification for doing so.

3.7 Instrument Design

Being a highly exploratory and qualitative study, the research made use of semi-structured interviews to garner the field data. These were deemed most appropriate in that they offer a less restricted response from the participants. Because real-time BI, and more specifically its pre-adoption considerations, is a relatively unexplored field, the research was able to gain from a thorough and deep understanding of the phenomenon. Semi-structured interviews are able to offer this type of insight. It is due to their open nature that the questions "encourage [responses that have] depth and vitality which allow [for] new concepts to emerge" (Dearnley, 2005, p. 22). In addition, semi-structured interviews assist in the discovery of perceptions that are unique to the South African context.

Where / when it could be done; the interviews were conducted in person so as to allow for a more engaging discussion. Where this was not possible however, telephonic interviews were arranged.

3.8 Pilot Study

No formal pilot study was used in this research process, although it was found that much could be learnt from interview-to-interview, thus allowing for the initial interview protocol in Appendix 1 to be adapted slightly. It is important to note that changes were minor, and did not affect the consistency of the interview process. Semi-formal email correspondence took place with the selected organizations to establish rapport and to preemptively inform the participants about the types of questions that would be asked. The idea was to reduce the risk of the participants being unprepared and subsequently not being able to provide full, detailed, and accurate responses.

3.9 Data Collection Method

3.9.1 Researcher Involvement

Walsham (1995) makes a distinction between an 'outside researcher' and an 'involved researcher'. Outside researchers typically carry out studies using formal interviews without any involvement in the field, such as the provision of feedback to the participants. An involved researcher however, is seen as a participant observer or involved in the field activity. Both of these approaches carry several advantages and disadvantages. In terms of this study, the researcher felt that it was important to provide feedback to the companies, not only as an empirical audit, but in order to provide incentive for company participation. On the other hand, due to the context and limited time-frame, the research did not permit action research to be carried out.

3.9.2 Interviewing

Interviewing is a critical part of qualitative research as it seeks to obtain the perceptions from the field of participants. As such there were several considerations that were accounted for to ensure the process was, to the best of the researcher's ability, conducted in an appropriate and effective manner.

First, the researcher aimed to strike a balance between passivity and over-direction (Walsham, 1995) in order to best carry out a semi-structured type interview. In other words, it was important to ensure that the interview remained open, iterative, exploratory, and continuous in order to garner the best information in the time available. Interview questions which have been overly prepared in advance tend to lock themselves into a specific scope and may therefore constrain the acquisition of additional information (Rubin & Rubin, 1995).

All interviews were recorded in order to facilitate a high caliber of information accuracy. As the discussions were open-ended and in-depth, note taking would distract from the natural flow of the conversation. Recorded interviews are also useful in that they do not constrain the researcher to one method of analysis, although transcribing the detailed interviews was a time consuming activity.

Other essential considerations followed included punctuality and maintaining utmost professionalism; these are considered highly important and also serve to reassure the participants of the caliber of the researcher.

3.10 Access/Ethics

Ethical considerations were adhered to and exercised in order to ensure that the research maintained the utmost credibility. At the preliminary stage, this involved obtaining consent from participant organizations (Appendix B). This included email correspondence and at times telephone calls which clearly explained the intentions of the study, the type of questions that were to be asked, the voluntary nature of the research, and the respect for privacy. In addition, the interview consent form ensured that the participants were informed of the ethical issues that are attributed to the research. Further, before the interview questions were used, they were submitted to the University of Cape Town's "Ethics in Research Committee" for review and approval.

The collected data was properly safeguarded and was not distributed or shared with anyone outside the research team (researcher and supervisor). Organization and participant names were also kept anonymous. Furthermore, organizations were offered the opportunity to review what was transcribed and taken from the interview. This not only ensured data accuracy, but also maintained ethical considerations.

3.11 Data Analysis

The data analysis was divided into two main components; the first involved the transcription and summarization of the recorded interviews (Appendix C). The responses were then assessed in order to segregate concepts into recurring themes/categories (thematic analysis); this also included the frequency of each response. Furthermore, categories were broken down into sub-categories in order to classify responses at a lower level. This required multiple reads through the transcription, in order to allow for concepts to iteratively evolve, and form better groupings. A spreadsheet application (Microsoft Excel) was the primary tool for data capture and management. Appendix D shows a snapshot of the database of extracted quotes, categorized according to their respective theme(s). As an inductive approach, the development of categories served to create a model that could accurately capture the key concepts that emerged from the research (Thomas, 2006). The following inductive coding approach (Figure 11) was the framework used to carry out this task.

Initial read through text data	Identify specific segments of information	Label the segments of information to create categories	Reduce overlap and redundancy among the categories	Create a model incorporating most important categories
Many pages of text	Many segments of text	30-40 categories	15-20 categories	3-8 categories

Figure 11 - The coding process in inductive analysis (Adapted from Creswell, 2002 as cited by Thomas, 2006)

Furthermore, it was important to finish with “three to eight summary categories, which in the coder’s view most captures the key aspects, … given the research objectives” (Thomas, 2006, p. 5). Thomas (2006) stresses that research which typically ends with more than eight categories can be seen as incomplete; in this instance however, categories can be combined.

The second stage involved a more comparative analysis where responses were compared and contrasted. In addition, patterns and relationships were grouped and noted at this stage. This required word processing tools such as Microsoft Word; here analysis results were analyzed, compared, and discussed.

Computer assisted qualitative data analysis software (CAQDAS), such as NVivo, is a good alternative for data analysis. The software is not readily available to all staff and students however and was therefore not pursued. The researcher felt that the Microsoft package provided sufficient functionality required to complete the data analysis in an effective manner.

3.12 Proposed Contribution

It is the opinion of the researcher that this study will not only contribute to the field of Information Systems, but will also explore a relatively new area of BI that has a relatively small body of research available to it. In particular, there appears to be a lack of real-time BI pre-adoption guidelines or considerations. In addition, the research may discover and/or enable new avenues for future research that can drive this discipline in broadening its domain and significance.

3.13 Limitations

The limitations of the study are discussed fully in the Conclusion (Chapter Seven).

Chapter 4 - Analysis (Part One)

4.1 Overview of Analysis Procedure

As discussed by Braun and Clarke (2006, p. 82), the qualitative thematic analysis process began by "look[ing] for some level of patterned response or meaning within the data set ... in relation to the research question". This began with a reading of the interview transcripts to identify emerging themes. During this process, the research questions and objectives served as a lens to guide the emergence of themes. In brief, the research set out to understand the challenges and considerations of moving into real-time BI (from a technological and business perspective), the application areas and related analytics of real-time BI, what benefits exist and how they influence the investment decision, and also what impact real-time BI has on its users.

The coding process began by extracting quotes where patterns of meaning and areas of interest were found in the data (Appendix D). Through each iteration of analysis, more themes continued to emerge and their links became clearer to the researcher. This initial coding process can be seen in Appendix E which shows several extracts that were coded and subsequently interpreted; this is only a snapshot of the process however. It was important to remain inductive during this stage so as to provide an objective view of the data set.

Being exploratory research, this also meant that the analysis needed to provide a latent understanding of the data meaning that would look beyond surface meanings of the text. As a result, themes were often linked and had been coded for multiple aspects and assumptions. It was during the axial coding process that, through linking and relating the themes, that they began to fall more naturally into place. Appendix F represents the categorized themes after 6 iterations of analysis. As this was the first draft of a framework, it was important to run it through the transcripts several more times in order to fine tune it.

Themes that could not be classified immediately were placed into a "miscellaneous" category as it was decided that they could bear significance at a later stage in the research. The "analytics" category proved to be somewhat difficult as there was a large amount of concepts and ideas within it. As such, the various components of analytics were then coded (Appendix G) in order to gain a broader perspective on them. After being coded, it was evident that a large majority of the analytics had elements of process / operational intelligence logic behind them (see chart on Appendix G).

After 10 iterations, and through combining the findings in Appendix F and G, there remained what were considered the most significant themes, as seen in Appendix H; these were classified under 6 main categories. Although these somewhat resemble the research questions, it is important to note that they were arrived at inductively and were only guided by the research objectives. From here, the researcher could analyze each category along with its subsequent themes. This was done in a way that not only discussed their implications in isolation, but also how they were related to other themes.

During data capture, the researcher also counted how many times each theme was mentioned (Appendix I). This proved useful in that it became clearer which themes were more dominant than others. Although this may be seen as a somewhat quantitative approach, it was only used to get a feel of the frequency of the responses. But in remaining interpretive in the research, the lesser mentioned ones were not necessarily deemed to be less important as they were treated as possible avenues for further research.

4.2 Overview of Themes

This section provides a brief summary of the six main categories that emerged from the analysis. They will be discussed in detail in the next chapter.

4.2.1Technological Considerations

The technological considerations are the IT-oriented aspects of real-time BI that were identified. These were based around the components of the physical architecture as well as other issues such as data and integration. This was included so as to shed light on how a system of this nature works, and to assess what difficulties were experienced in putting one together. In doing so, organizations that are planning to apply real-time BI can have a fuller understanding of what a system of this nature requires, given the current capacity of IT tools. It is not a strict list to follow however, but rather to provide a guiding framework that could help practitioners understand the technological side better.

4.2.2 Organizational Considerations

This category explores the non-technological considerations which are decision and focus areas that need to be assessed at the business-level. Similar to the technological considerations, these are likely to vary depending on the organization. However, it is more than likely that some, if not the majority, will be experienced somewhere along the line during implementation. In doing so, organizations can be better poised to deal with them when they arise. The trouble is that if they are overlooked and realized too late, they can be seen as a potential disturbance to the success of the project.

4.2.3 Users

As with most IT implementations, it is common practice to understand what impact it will have on the user. Here, three main areas were looked at: issues of participation and adoption, how the system will facilitate the user (particularly in decision-making), and issues around the user's data requirements. As the user is the one who interacts with the system, it needs to be designed in such a way that facilitates the user, both on the interface, as well as in terms of functionality. In addition, the user needs to know exactly how the system will affect their day-to-day decision making. Failing to acknowledge these considerations may severely compromise the success of a new system.

4.2.4 Analytics

In this category, real-time BI will be explored in light of where it was applied in the business as well as the types of analytics that were leveraged from it. Furthermore, where possible, analysis will be conducted around how the analytics were configured from a more technical perspective. It is important to note that the analytics which will be discussed are only those which surfaced from the research. Although others do exist, possibly with different configurations, the idea will be to find the common elements between them. By understanding the common elements and the logic behind the analytics, that knowledge can then be applied elsewhere. In addition, this may facilitate in the discovery of other application areas to which real-time BI can be applied.

4.2.5 Benefits

The purpose of this category was to reduce the findings into valuable and derivable business benefits. In other words, the identified value statements were categorized into quantifiable and measurable improvement areas which are essentially the core benefits of real-time BI. Because benefits are one of the main factors driving the investment, it will be useful for practitioners to better understand where they should be looking to find value. Also, in terms of the business case, these will be crucial components to include. Furthermore, by assessing how organizations went about realizing these will serve to demonstrate how their worth was determined.

4.2.6 Investment Process

The investment planning category investigates how organizations went about their investment endeavors for their real-time BI system. More specifically, the idea was to look at the stakeholders involved, the investment process, the financial and non-financial justifications, as well to discuss several other findings. Because an organization may potentially receive multiple IT project proposals, if they are not well justified, then they can be easily disregarded. For an IT initiative to be successful it first needs to demonstrate value in order to receive investment attention. It is for these reasons that the research has included an insight into the investment procedure so as to equip organizations with the knowledge required to succeed in their business proposals.

4.3 Company Profiles

This summarizes relevant information on the five companies interviewed and their real-time BI applications. In future analysis they will be referred to by the codes shown in Table 3.

Case	Code	Industry
Company 1	Co1	IT Consulting
Company 2	Co2	Financial Services
Company 3	Co3	Retail
Company 4	Co4	Energy, Retail
Company 5	Co5	Transport

Table 3 - Participant Company Profiles

Case 1: Co1 is a small-medium sized IT consulting company who provide business and software solutions to clients. Being an entirely service-based organization, their real need is around people. As such, they understand that their value, as an organization, comes from their employees. This however, was being compromised due the high rate of employee attrition, coupled with the difficulty of finding and retaining talent. Not only is it expensive to re-hire and train a new employee, but attrition was found to have an impact on performance. It was from this that the idea to build a socially driven employee relationship management system (SDERMS hereafter) came from. Co1 realized that if they could monitor work-related aspects of their employees, in terms of job satisfaction and performance for example, then they could learn and better understand indicators of attrition. With this knowledge, they could be better poised to proactively address situations, such as an employee's likelihood of leaving, and potentially rectify that situation before it could materialize. The aim of the system is also to enable employees to function optimally as individuals and as teams, thereby driving business performance. In a service organization, it makes a big difference when employees put discretionary effort into their work. Managing and nurturing that, therefore, was another driving force behind the proposed system.

Case 2: Co2 is a financial services provider, specifically in long-term savings. From an IT perspective, this meant a large focus on IT security, namely in the forensics function. While forensics is normally after-the-fact, Co2 purchased a system that would allow them to be more proactive in their forensic space. The decision to implement this system was due to the high rate and cost of fraud, and more so, the inability to find it in time. Instead, it was only discovered during audits (after-the-fact), when the transaction had already been processed. It was also often found that fraud was correlated to insider jobs where syndicates would work together to facilitate malicious transactions. Furthermore, as further leverage, Co2 utilized a projection by the ACFE (American Certified Forensic Examiner Association) which estimates 5% of an organization's turnover to be the amount of fraud; for a company that realized a R70 bn turnover in 2009, this would amount to an estimate of about R3.5 bn in fraud. As such, the system would minimize the impact of fraudulent transactions by finding them before they could be processed, thus reducing the resources spent on recovery.

Case 3: Co3 is a large retail chain that operates over 1200 outlets, under a variety of names, in South Africa and others across Africa. For many years, Co3 relied on its Data Warehouse, which was only refreshed nightly, to make decisions regarding its stock levels. This however, was ineffective because the stock level, from which decisions are made, was a day old and therefore did not provide an accurate representation of the actual level. As such, when an item(s) was out of stock, they could only realize it a day later, and would have to wait another day to replenish it; thus amount to a 48 hour restock period. Wanting to react faster to stock out situations, Co3 began implementing real-time monitoring on their POS systems (point of sales); this allowed them to monitor sales in near real-time. But having real-time visibility at the POS level not only gave them better visibility on their stock, but opened up the opportunity for a large range of analytics and decision support.

Case 4: Co4 is an oil company that is a player in the refined petroleum products market. Their core business is in refining crude oil, marketing of refined petroleum products, and the provision of convenience services across their retail network. Having over 1000 service stations across South Africa as well as others in Sub-Saharan Africa, there focus, in terms of real-time BI, was mainly in their secondary distribution. This includes the moving of product (petroleum) onto retail sites; its volume, turnover as well as mode of transport. In addition, because the retail sites operated convenience stores, these would also be monitored in real-time.

Case 5: Co5 is an aviation company that operates two major airlines, both within and out of South Africa. The difficulty was that it was operating these airlines with separate operational systems. In addition to having no integration between these core systems, they were also highly desegregated. Initially, Co5 tried to overcome this problem by putting everything into a Data Warehouse from their non-integrated systems. They soon realized however, that they could not continue to rely on ETL processes to fix deficient data, from host systems and processes, at a DW level. As a result, information was not always accurate which resulted in people making decisions from different versions of the truth. As such, this meant restructuring and integrating their systems into a single enterprise-wide tool that could manage their operations, flights, and bookings in a single space; it is here where the opportunity for real-time was realized.

4.4 Respondents

Table 4 lists information of the respondents who took part in this study.

Respondent	Co. Code	Industry	Area	Position
1	Co1	IT Consulting	IT, Non-IT	Strategy & HR
2	Co2	Financial Services	IT, Non-IT	Forensic Manager
3	Co3	Retail	IT	BI & Integration Manager
4	Co4	Energy, Retail	IT	BI Manager
5	Co5	Transport	IT	BI Manager

Table 4 - Respondents

Chapter 5 - Analysis (Part two)

In this chapter, detailed analyses of the findings are presented. The findings discussed here are, in order, analysis of technological considerations, organizational considerations, application areas and analytics, users, benefits, and the investment process. The analysis findings are also supported by quotes from interviewees. Each quote is given a code according to its category, followed by an identifier code; these are TC, OC, A, U, B, and I (respectively). Some quotes have been used to support the write-up, but which have not been included; these can be found on Table 12 (preceding the final reference list).

5.1 Analysis of Technological Considerations

In this section, various fundamental technological elements of a real-time BI system will be explored. Although it was found that BI architectures will vary depending on their context, their underlying technical structures share common components. Above all, the message-bus was found to play a critical role in the entirety of a real-time BI architecture; it integrates organization wide systems into a single data channel that is used to funnel transactional data into the DW. The message-bus can then be intercepted, with things like Operational Data Stores, and monitored in real-time. Other considerations included issues around the type of data used and how it is used, the importance of integration, and the need for flexibility.

5.1.1 Integration

While it is common for organizations to run multiple systems to support their various business functions, they need to be integrated in a BI environment. Information can no longer be kept in isolated repositories but must be consolidated in order to provide a unified view.

> *"…here there are 65 different ERP systems that run this business"* (TC26)

> *"We then also use sales-order placement, CRM systems, demand planning systems, financial consolidation systems, business planning systems, also SAP / SAP-related systems; all of those get fed into the central data warehouse"* (TC65)

> *"… [we] can't create little silos of information in certain areas (service-level areas), that information needs to be brought across"* (TC39)

As such, integration is a key component in creating a technical landscape that supports real-time BI. This sub-section explores the various challenges that organizations that were encountered during the process of integration.

At Co5, integration was undertaken as the first task because they had been running their airline systems completely separately, with no integration between them (TC50). Without integration, they were unable to provide accurate information to the business which compromised business visibility, and the quality of their decision-making.

> *"… there's been difficulty with getting information out based on non-integrated systems, and have therefore had people in the organization with different versions of the truth"* (TC87)

Not only were systems lacking integration, they were also highly dispersed around the organization. This made integration even more difficult because it became a logistical challenge (TC81). More so, these were the core operational systems of the respective airlines. As a transport company, it could not allow to have its systems down as it is in constant operation. An upset to the workings of the systems could have detrimental impacts.

Similarly for Co2, the priority was to ensure that integration did not affect the workings of their business processes and systems (TC40; TC14). For a financial services organization, non-impactful integration was seen as critical requirement because an upset to the system could potentially result in the overlooking of a fraudulent transaction(s).

For many large organizations, such as retailers and banks, legacy systems were found to still support many business functions. Legacy systems integrate differently however. Co3, who still use legacy systems in their retail space, expressed difficulty in integrating them because they are not really designed for real-time.

> *"[legacy systems] aren't really geared for real-time"* (TC56)
>
> *"…in a retail environment, your legacy stuff is all typically flat-file based. So it's a bit more of a challenge moving retailers into real-time"* (TC24)

Legacy systems are said to require flat-file based integration because they have to process large quantities of transactional information (TC23). For Co2 and Co4, this meant having to migrate from multiple platforms and legacy systems onto a single platform.

> *"it's been a journey … to migrate from [our] existing legacy systems onto a single platform"* (TC67)

Migration is an important part of the process because all of the data, especially from the legacy systems, needs to be brought into one unified space. Enterprise-wide system consolidation however, is not a once-off process; it needs to happen automatically and continuously so that there is a real-time flow of information. To do so, the implementation of a communications-channel or message-bus (also referred to as an Enterprise Service Bus (ESB) in SOA) is a widely accepted solution for integrating multiple systems. It does this by integrating them into a single data channel which is then directed into a DW.

> *"The first thing I did was to take over the integration, and this was to move into the real-time BI space. We implemented an ESB, began breaking up and re-organizing the integration between all the ERP systems"* (TC25)

> *"…it starts at the integration between the systems, so you need to plug into that an integration layer, [some]thing like an ESB"* (TC76)

A major advantage of a message-bus is that it enables the integration and communication between systems without impacting other components. Furthermore, it can also assist with the issue of integrating legacy systems. It does this by breaking their flat files into messages, which are sent through the message bus and then re-assembled, and integrated on the other side (TC30).

It was advised that the integration process is monitored so as to ensure that it is being executed correctly. This is important because if a system has, for whatever reason, not integrated, the information from which decisions are made is will be inaccurate. For example, Co3 has a retail system that can detect when a shelf-gap or stock-out situation occurs. It works by detecting when an item's actual rate of sales significantly deviates from its average rate of sales (A48). However, if that system has not integrated correctly and no transactions are being seen by the system, the alert for a shelf-gap / stock-out situation will be inaccurate. Solutions such as BAM tools can be used to automatically monitor and ensure that systems are integrating correctly, and that information is valid.

> *"…you need to start monitoring all of that, so you have a business activity monitoring layer which says [that] you can use the information in this system to make decisions because it has integrated with the other system over night"* (TC27)

> *"…if that ERP system has a different set of master data and isn't in sync with the rest, you can end up giving the wrong information, which is also quite key"* (TC35)

All in all, integration is a truly fundamental step towards building an environment that is geared towards real-time BI. In doing so, there are several other core technical aspects that need to be discussed.

5.1.2 Message-Bus

The message-bus, as briefly discussed, is another key component of a real-time BI architecture as it provides the means to permanently integrate an organization's systems and route their data into a repository. Consequently, this addresses many of the challenges that come with the integration process. This includes integrating internal and external systems (including legacy systems) into one space and doing it in a manner that does not impact business systems.

> *"ESB is really the communications between the different … systems, as a basis, so it's an integration layer"* (TC20)
>
> *"So all of our 65 ERP systems speak through your central ESB"* (TC29)

As such, the implementation of a message-bus can be seen as one of the initial steps to configuring a real-time BI architecture.

> *"You've got to select a message-based integration platform, that's number one."* (TC48)
>
> *"…try to move everything to a message-based environment."* (TC21)

The value of a message-bus comes not only from its ability to integrate systems, but because the data flowing through it can be intercepted (TC30). By intercepting the real-time data, there are a host of analytics that can be applied to it. To do so however, it needs to be trended against historic data in order to contextualize it.

> *"…it can get information, or transactional information, the moment something happens"* (TC8)
>
> *"The beauty of an ESB is that you can inspect that stuff as it flows through"* (TC31)

In light of this, the importance of a message-based integration platform is emphasized, as it is in many ways the backbone of a real-time BI architecture. Organizations need to also understand the data that flows through the message-bus because that later plays a major role for analytics.

5.1.3 Data

Generally speaking, it was found that most organizations capture and analyze transaction data for analytical purposes. This is data that has a time dimension, a numerical value, and that is associated with an object(s). For instance, it can be a sales transaction which contains a date/time, monetary value, and product. These are structured forms of data that can be gathered and analyzed relatively easily.

> *"…to do analytics on it, it needs to be structured in some way"* (TC5)

Typically, there is a lot of transaction data because it is created every time a system has any sort of output. For example, as a retailer, Co3 produces a large amount of transaction data directly from its tills (TC36). Transaction data can also be data from the the output of a system such as a log of business process execution times. This transaction data can then be quantified and made sense of because it is structured. Making sense of it however also requires master data. Master data is reference data, which is non-transactional (qualitative) data that serves to define transaction data. For the case of the retailer, this could be information related to products and suppliers. At Co2, master data is needed for when fraudulent transactions are being analyzed, namely the details of the policy, such as the policy owner pertaining to the transaction (TC15). The implementation of a master data management environment is advised in order to ensure that master data information is correct.

> *"You've also got to select a master data management environment"* (TC50)
>
> *"There is also a lot of master data management implementation as well to normalize your master data across all the systems in order to move into real-time"* (TC33)
>
> *"…if that ERP system has a different set of master data and isn't in sync with the rest, you can end up giving the wrong information"* (TC34)

While most organizations only analyze transaction data, with the exception of master data, Co1 offered interesting insight into enriching analytics with non-transactional (qualitative) data.

> *"What is interesting is combining that [transactional data] with a lot of the softer data, things like social business networking type data"* (TC2)
>
> *"We look at the take up of social networking software; it's that kind of data which is adding that to the transactional data"* (TC3)

This is interesting because softer data can serve to put transactional data into context. For instance, their system (SDERMS) allows employees to rate their work satisfaction. While this is valuable information for the business to know, it is far more valuable if it can be supplemented with descriptive qualitative information. This would help to identify the reasons why an employee may be un/satisfied, which for a business that wants to reduce retention, is advantageous to know. Unlike transaction data however, Co1's "social data" is non-transactional and is therefore not structured.

> *"But some of the other data [non-transactional] is hard to get into a form that you can apply analytics to"* (TC92)

In order to apply analytics to a collection of data, it must be organized in a structured way so that it can be quantified. For Co1, this involved a separate process to filter data through a rich text / content analytics engine (TC94).

Furthermore, organizations must also assess their requirements in terms of data latency and subsequently decide how they define real-time (TC91). This is because latency requirements are business-specific; they are based on the particular needs of the organization. These are normally decided at a business level. For example, because Co5 have a big focus on on-time performance (i.e.: flights being on time), they could base their latency requirements on that requirement (A107).

> *"As a customer, if your plane is 10 minutes late, you would consider it late. But from a [Co5] perspective and an industry perspective, anything within 15 minutes is considered on time. So within the business we have to make sure that we define what on-time means"* (TC95)

Co4 add that, the frequency at which information is distributed should be aligned with how often that information is actually being used to make decisions. For instance, delivering information that is refreshed hourly when an organization only makes decisions once a day will be of no benefit. This may also result in additional costs incurred from making those load changes.

> *"I can change something every 5 minutes, but if you're only using it to make decisions every 2 days then it doesn't make a difference"* (TC59)

> *"It's nice to know certain patterns every hour, but if it's just FYI (for your information) and you're not using it to make decisions, then you need to look at the cost of making those load changes in terms of frequency and the benefit that you're actually realizing from that"* (TC60)

It is also important to understand the delays that are associated with data. After data is produced at the host systems, it is not necessarily immediately ready for analysis.

> *"There is about a 15 minute delay; so if something scans [on the tills] in Mauritius, we will have it here 15 minutes later"* (TC37)

The ETL process is one of the major reasons why this delay exists. After data is created, it needs to be sent through the message-bus, transformed into a structured form, validated, and loaded. This affirms the need to reduce data latency times in order to achieve a real-time environment.

> *"…that is kind of validated and checked and there is a whole lot of ETL and validation because you're just getting a raw transaction"* (TC38)

In addition, Co5 stress that ETL processes should not be used to fix incomplete data. In other words, they need to ensure that data is validated at its source (host systems) by using business rules.

> *"The first and most important thing is to get the data correct at source"* (TC88)

> *"You can't have these sophisticated ETL processes which are going to try and fix deficient information, you shouldn't do that, your business rules should be on your systems and not on your ETL processes"* (TC85)

With these considerations in mind, there is evidence to suggest that implementing such an architecture requires a good understanding of the many technical components that fit together to enable a real-time BI environment. Organizations wanting to implement real-time BI should be prepared for the acquisition of additional tools and technologies, but should also have a thorough understanding of the role that the various components play.

5.1.4 Architecture

From what has been discussed thus far, there are a number of technological components that have surfaced from the research. This includes, but is not limited to, master data management, analytical tools, BAM, ETL tools, as well as the message-bus.

> *"… there is that whole infrastructure you have to put down, with your [message-bus], and all you data flowing through your [message-bus]"* (TC28)

> *"… you're creating a whole new level of aggregation which requires different technology"* (TC45)

In order to understand how these various components work together as a system, Figure 12 offers a high-level view of how they interact. Although this diagram is an amalgamation of the various findings thus far, it was found to correspond closely with the architecture that was described by Co3.

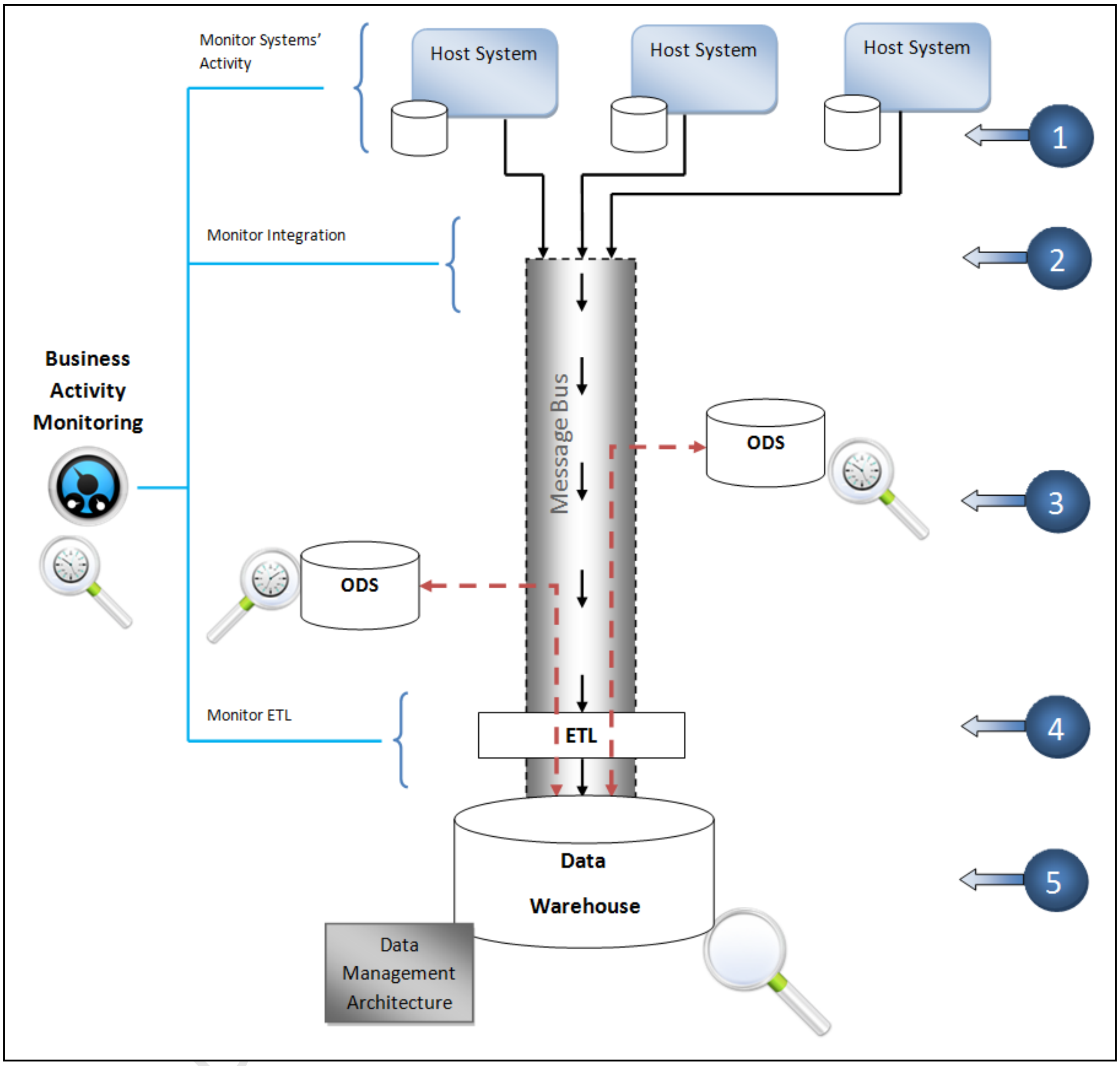

Figure 12 - Representation of a real-time BI architecture and its components (derived from research)

In short, this can be described as a five stage process: data is created at its host system (1), it is then integrated and brought into the message-bus (2), it is intercepted at the message-bus for analysis (3), and it undergoes ETL processes (4) before it is consolidated into the DW (5). In order to harness real-time analytics, a new component was introduced; the Operational Data Store (ODS). The ODS sits between the host systems and the DW and intercepts data flowing through the message-bus and then trends it in real-time by comparing it against a normalized snapshot of the DB. Unlike the DW, the ODS does not require significant data cleansing, consolidation, or quality management; instead it stores a limited scope of data thereby allowing near-real-time updates and analytics (Melchert *et al*., 2004).

> *"... you can intercept information at the [message-bus] and compare it with historic data to start a business event or to alert a situation"* (TC78)

In order to make sense of this data, it first needs to be put in context. This is where historic data, which is derived from the DW, fits into the picture. For example, while it would be useful to know how many items have been sold in one morning, it would be far more valuable to know that number in comparison to the week, month, or year. In other words, if the current data can be compared to contextual data such as average sales, frequency of purchases, and trends, then it will add more valuable insight.

> *"...you need to bring that real-time, and you have to put it in context with historic data from the warehouse; the history defines the future. Transactional data is checked against its KPI constantly, but that KPI is determined by the information in your DW."* (TC73)

Interestingly, the ODS will consolidate data until it is scheduled to update to the DW, and in doing so, will refresh its own set of historic data in order to stay current (TC41).

> *"That ODS can then be queried, but that will be pushed into the DW for historic data. But you will use that historic DW data to monitor on your ODS."* (TC80)

This is important because analytical environments (represented on Figure 12 by a magnifying glass) leverage historic data from the ODS. For instance, a KPI needs access to historic information as it monitors real-time data. By keeping the ODS's data current, the KPI is itself accurate. It is for this reason that the diagram illustrates a two-way flow of information from the ODS and the DW (represented on Figure 12 by the dashed red line).

> *"Let's say you go into a system and put in a threshold for an alert; that information is derived from your historic data. You see it needs to be a dynamic KPI so that the threshold is updated ... based on your history"* (TC75)

In addition, many organizations apply BAM analytics where they can directly monitor business activities, as they are executed at their host systems. In some cases, BAM was also applied to monitor integration and ETL processes to ensure that they are being executed correctly (see Figure 12). Analytics can be applied at separate tiers, at the operational level, at the ODS level, as well at the DW where OLAP environments typically exist (historic analysis). There was however mention of a different type of analytical configuration that Co4 had introduced in isolated business areas. This is an in-memory solution which is a stand-alone analytics layer that sits on top of transactional systems; it is therefore independent of the DW (this is not included in Figure 12).

> *"That in-memory type solution would mean that we would probably be looking at solutions that are sitting on top of your transactional systems with in-memory capabilities."* (TC69)

The in-memory solution works by indexing the transactional system constantly (TC71). While this type of configuration does not require a DW to operate, Co4 believe the DW will always be around for consolidation purposes.

> *"The data warehouse will always be around for consolidation purposes, for monthly reporting, for different reasons. But a lot of your real-time BI would not require a warehouse of any type, won't require a copy of your transactional system, it would just read straight from your transactional system"* (TC72)

Although there is no one single blueprint for a real-time BI architecture, the proposed configuration in Figure 12 gives a holistic view of how the various components work together. As such, organizations should implement an architecture that best suits their business need(s) and context. The architecture should also allow for some level of flexibility, that is, because a business' needs are not fixed and may not be realized immediately, the architecture should allow for changes to be made when they are required.

5.1.5 Flexibility

As business needs change and evolve, so should the system that supports them. For example, if products or departments change, business processes will change too. The real-time BI system should therefore be able to accommodate for these changes without major interruptions or configurations. Similarly, if latency requirements change, the architecture should, to reasonable extents, be capable of making those changes.

> *"We have a fairly stable technical landscape, so we can run at any frequency; it's really making sure that the business is ready to receive it"* (TC62)

As an organization grows, its data and analytical requirements are likely to change too. Often, analytics are discovered through the innovation of their users. This calls for a real-time BI environment that can cater for this kind of change.

> *"…a huge amount of analytical stuff, some of it is done just through the innovation of an individual sitting there planning something and will discover something"* (TC53)

> *"So it's an ever-learning environment, and you grow on top of that"* (TC54)

Therefore, flexibility not only ensures that systems can accommodate for changes in the business environment, but that analytics are not fixed. This is an important aspect for ensuring that there can be innovation in analytics.

5.2 Analysis of Organizational Considerations

In this section, various organizational considerations of implementing real-time BI are explored. As a preliminary measure, organizations are encouraged to assess their own BI maturity level in order to understand both where they currently are and what still needs to be done in order to move into real-time BI. Also, change management strategies may need to be applied during business process re-engineering procedures, and to also facilitate users to accept changes in their business environment. This is also important for overcoming issues of user resistance. Further, organizations must decide whether they are going to build or buy real-time BI solutions; findings show that it is generally cheaper and less time-consuming to buy, unless there are adequate development skills available in-house. When buying, vendors should be assessed in terms of maturity, IT skills, and availability of support. Similarly, organizations need to assess their own level of IT skills as these are required for implementation and on-going support. Because the required skill sets for real-time BI are diverse, they need to be brought together, managed and made available. Other issues include the need to define business rules to ensure that there is a common standard for which data is monitored and measured, and essentially a common standard of information. Lastly, because real-time BI is associated with high implementation costs, it is crucial to identify quantifiable business problem(s) or opportunities that can drive the investment and justify the costs.

5.2.1 BI / DW Maturity

As a preliminary step for planning real-time BI implementation, organizations are encouraged to first assess their own BI / DW maturity level. Rajterič (2010, p. 49) states that each level of maturity has key process areas, and that those areas "represent phases which need to be completed by the organization in order to achieve a certain level of maturity". It is important that this assessment is conducted because organizations should not rush into developing real-time systems if they have not yet implemented the necessary architecture, or if standards and key processes are not in place.

Co5, a recent adopter of BI, expressed that, to achieve its goal of implementing real-time BI, it would aim to first develop the traditional BI side first.

> *"BI in [Co5] is still a new concept, we are very young"* (OC57)
>
> "*… our systems are highly de-segregated and non-integrated; that's one of the challenges we've had. 2 years ago the idea was, if we put everything into a DW from all these non-integrated systems*" (OC76)
>
> "*… because there's been a difficulty with getting information out, based on non-integrated systems, we've had people in the organization with different versions of the truth*" (OC75)

Because Co5 is still in an early stage of BI maturity, they recognize the importance of getting the basics right and then iteratively evolving into the real-time BI space. An organization needs to first develop the basics, including enterprise-wide system integration and implementation of common standards, as well as to develop skills around that. This reinforces Rajterič's (2010) claim that organizations need to match their own maturity level to that of their BI. A more mature BI / DW is also likely to have larger amounts of historic data, which means that more value can be attained from monitoring real-time data. It is for these reasons that Co2 and Co3 recognize the importance of having maturity in this space.

> *"... we've got quite a mature function from a warehousing or a BI kind of perspective"* (OC10)

> *"Obviously we've put in the traditional data warehouse which we've had for a number of years now and it's really mature"* (OC20)

It is more likely, for organizations that are not yet mature in their BI / DW spaces, to run into obstacles when implementing real-time BI. As such, there are many BI maturity assessments that can assist organizations in assessing their readiness before they begin to explore more sophisticated realms of BI. Furthermore, because real-time BI requires business process re-engineering, organizations need to be at an adequate level of maturity before undergoing this phase.

5.2.2 Business Process Re-engineering

A business process, simply put, is a logically related set of steps that carry out a business outcome (Kettinger & Grover, 1995). In a real-time environment, where data can drive business processes, the need for configuration and re-engineering of processes is a likely requirement.

> *"... first of all its going to change a bit of our business processes"* (OC19)

The idea behind process re-engineering involves "the implementation of deliberate and fundamental change in business processes to achieve breakthrough improvements in performance" (Kettinger & Grover, 1995, p. 111).

Although process re-engineering was not discussed in detail in this research, literature suggests that because of the broad organizational focus and deliberate nature of BPR, there needs to be planned change which requires "preparation and deliberate action, support from management, technical competence, and mitigation of resistance to the change" (Grover *et al.*, 1995, p. 111).

In a real-time BI environment, where enterprise-wide systems are integrated, the reengineering process is likely to be a major task. For these reasons, change may need to be managed.

5.2.3 Change Management

It was suggested that the change required for implementing real-time BI may therefore warrant the use of change management strategies. Change management is needed for two things: to facilitate business process reengineering (Kettinger & Grover, 1995) and to help individuals accept changes in their business environment (Aladwani, 2001). Kettinger and Grover (1995, p.12) suggest that BPR should be accompanied by change management strategies which focus on the "relationships between management, information, technology, organizational structure, and people".

Furthermore, when implementing IT, organizations should be cautious about users' resistance to change. According to Sheth (1981), the most common causes of user resistance are perceived risk and habit. It is for this reason that change management strategies need to be exercised because failure to manage change has been noted as one of the foremost reasons why IT initiatives do not succeed (Stratman & Roth, 1999).

For example, Co3 implemented a policy aimed at managing the quality of their master data by holding users accountable for the quality of their data. In response, many users showed resistance to the policy because they would have the burden of upholding additional responsibility.

> *"master data management … is very change-management oriented because … [you're] pushing the responsibility of the quality of the data into the organization, they're often quite resistant to that because you're making them responsible for the quality of data"* (OC30)

Furthermore, the idea to automate the stock ordering process at Co3 was initially resisted by business. A major change like this not only requires change management, but obtaining trust; these are issues that require planning and strategy.

"… auto prediction itself, in terms of implementation, not from a systems perspective, but from a perspective of change-management with people and trust of those predicted orders is quite a slow process" (OC22)

As such, Aladwani (2001) stresses that organizations need to implement strategies that promote the infusion of new initiatives. In doing so, it is important to first understand the causes of resistance and then develop strategies to address them individually. Furthermore, because real-time BI is an enterprise-wide initiative, it will have wide impact. Its implementation must be managed, both in terms of reengineering efforts where multiple stakeholders are involved, and in terms of the user.

5.2.4 Build versus Buy

The decision to build or buy a solution should also be included in the preliminary planning stages of the project. The general view, from organizations that are not in the software development industry, is that to develop and mature a product internally is far more time-consuming and costly than it is to buy it.

"...we try and buy everything; it's just a lot less expensive for us" (OC77)

In contrast, Co1 who is in the software development industry, realized that not only could it use its own internal skills to develop the system, but that it could sell it to clients as a solution after it had been matured.

"… we turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients" (OC66)

If the decision is to buy however, there are several things that are important to consider. For instance, Co3 was faced with a situation where there was nothing on the vendor market that could satisfy their technology needs.

"… there are situations where there is nothing on the market; … that allows us to do it in the fashion we wanted to do it in" (OC31)

"… aren't vendors out there that have got to that level of sophistication" (OC23)

This meant that they had to tailor a solution by purchasing several components and integrating them together. This however, will require the appropriate skills needed to then configure the solution.

"so [often] there is no one vendor that has everything" (OC38)

"Sometimes the solution becomes purchasing one or two items and plugging them together and coming up with a solution" (OC36)

"... fair amount of customer configuration; it's not all plug and play" (OC29)

There were also instances where vendors alleged that they were capable of delivering more than they were able of (OC37). As such, Co3 stress that vendor research and assessment is an important part of this process. Notable factors included vendor maturity, skills, and availability of support (OC16).

"[do they have the] skills available to support it?" (OC54)

The process of researching and reviewing vendors is also two-fold. In doing so, organizations have an opportunity to learn about what is on the market and discover what kinds of technologies and analytics exist.

"... we didn't really think there was anything that could answer this question, so we never really asked the question" (OC8)

"... we didn't really know the change was needed until we saw this product that can do it and realized the value" (OC9)

Therefore, whether the decision is to build or buy, vendor research is an important and valuable part of the process. Furthermore, organizations need to assess whether they have the skills, internal or external, to support their initiative.

5.2.5 IT Skills & Support

Much of what has been discussed thus far, particularly regarding implementation, will require the skills to put it in place and also to support it. In addition, it is crucial for those implementing real-time BI to have a good understanding of the business.

"The people implementing it also need to understand the business" (OC67)

This may require that IT staff become more knowledgeable of the business. In doing so, they can understand what it is that the business needs, what problems they are facing, and can therefore suggest appropriate solutions.

Co3 explain that, the move into real-time BI was a challenge for their implementation team because they had to familiarize themselves with new tools and technologies surrounding real-time BI. This suggests that new skills may need to be attained.

> *"... moving into a [completely] different realm of integration and ESB and messaging systems, which a lot of them don't have experience in"* (OC68)

> *"... you've got to really get into the systems and understand them quite a bit more"* (OC42)

Furthermore, because there are a wide range of skills required for real-time BI implementation, it may be challenging to actually bring those skills together and manage them.

> *"... if you're going to move into real-time BI, in a large environment / corporate, you're going to have to have the integration teams, the guys who put in integration and ESB etc., they have to work very closely with the BI guys . You've got to mesh those skills, which itself, internally in an IT department, is a big challenge"* (OC44)

It is important to realize that garnering the necessary skills is not a once off task; they need to be available for ongoing support. For instance, if there is a technical fault or a request for a change, it is vital to have support staff on hand to respond to those needs. Whether organizations rely on internal or external skills, they need to ensure they are well managed, available, and have a good understanding of the business.

5.2.6 Business Rule Definitions

Before organizations can begin to monitor data and apply analytics to it, they need to ensure that they have business rules which are defined as this provides a common standard of what information means. A simple KPI for example, will monitor a particular measure of performance. When data is monitored through that KPI however, it will be checked against a business rule (e.g.: process execution times should take no longer than 2 minutes).

By defining business rules, organizations are essentially defining what it is they are going to monitor, and how they are going to monitor it.

> *"... [it is the] golden standard of what information means"* (OC60)

Defining business rules, in some cases, can be a challenging task however. For example, Co5 wanted to monitor performance metrics such as on-time flights but had to first define exactly how they would measure it. Similarly, because calculating profit in a service industry is somewhat unclear, this too had to be explicitly defined.

> *"... on-time flights; where do you start to measure it? Is that when the last passenger is on the plane, or from the time you're given permission to take off etc"* (OC59)

> *"Profit for example, it's not as straight forward [to measure] without being defined, in the Airline industry it is complicated to measure revenue because of when it's recognized. Is it once the person flies, doesn't fly? Because if you pay me for a ticket but haven't flown yet; it's still your money because I haven't rendered the service yet"* (OC61)

In the absence of business rules, there is no common "golden standard" of what information means to the organization. Co5 explain that this is an important process to ensure that there is one common interpretation of information. This ensures that decisions are made from a single (objective) version of the truth.

> *"... if your definitions (your golden standards) aren't defined, you're going to have a serious problem about even getting to the single version of the truth because no one has defined [those] business rules"* (OC59)

It is evident that because business rules are context-specific, every organization needs to assess its own requirements and objectives first. Once they are defined, they will play a crucial role in monitoring data.

5.2.7 Requirements / Driving Force

Amongst the various themes under this section, most frequently cited was the importance of understanding what is driving the investment. This is because IT investment decisions are typically triggered by business requirement(s), and these are the driving forces of the proposal. Organizations need to first identify to what area(s) real-time BI can be applied to in a way that offers some kind of quantifiable value. These are areas where real-time BI can address either a business problem, or harness an opportunity. This is considered a fundamental component of a successful IT initiative. Although requirements are of particular importance for quantifying and justifying the investment, as will be discussed in detail in the Investment Chapter, the purpose here is to explore how organizations arrived at those requirements.

In Co1's case, the need to decrease employee attrition and subsequently increase retention was recognized as the primary driving force of the proposal. Attrition was not only negatively impactful to project productivity, but it meant that resources had to be spent on re-hiring and training the new staff. To reduce attrition, Co1 wanted to have better visibility over its employees; for instance, on work satisfaction. By monitoring metrics such as these, they would be better prepared to respond to situations that could lead to retention. More importantly, they could do so proactively which would allow them to remedy problems before they can materialize.

> *"3 or 4 years ago we started to see how difficult it was to find and retain talent, and it was driven out of that"* (OC5)

> *"... the ideal would be to get those indicators through and things like likelihood to leave, in real-time; then we can take proactive action"* (OC2)

It was therefore relatively easy for Co1 to define and quantify the driving requirements for their proposed system. Similarly, Co2 wanted to take a proactive approach towards fraud. Formerly, they would respond reactively to situations of fraud; this however was resource intensive because they would need to carry out recovery procedures after the money had been issued. By identifying and isolating all the fraudulent transactions that could have been stopped, had there been a system in place, they were able to derive a quantifiable requirement to justify the investment. Furthermore, issues such as insider knowledge and information leakage were also noted as push factors of their proposal.

> *"I looked at everything that was reported to forensics and from that I isolated the items that I believe a good enough technology could [have] picked up"* (OC18)

> *"... battling with this thing about the 'trusted insider' or 'information leakage' and the difficulty of finding that in the system"* (OC7)

For Co3, the driving force was both a value-seeking opportunity and a response to a business problem. This is because, enabling real-time visibility at the POS (point of sales) meant that they would have better in-store visibility. On the other hand, real-time POS would also allow them to respond a lot quicker to shelf-gap situations (when a product is unavailable to the consumer either because it is out of stock or is sitting in storage) and therefore minimize the impact of the foregoing sales.

> *"I took the Point of Sale (POS), so the most value in terms of a retailer is that if you can see what's happening at the POS in sort of split seconds"* (OC21)

> *"So obviously we had to bring forward the shelf-gap monitoring as quickly as possible"* (OC40)

Although real-time POS visibility was the primary driving force for the investment, push factors also included the need to integrate information silos (data marts) in service-level areas (OC64).

In many instances, organizations will implement systems aimed at particular business needs, as mentioned above, but will then gradually discover new areas of application as they familiarize themselves with the technology. These observations show is that it is crucial to first isolate and define the business requirements that are driving the investment. In doing so, they can be quantified and used as measures to justify the resources that will be required to carry out the proposed project.

5.2.8 Cost

One of the main resources required to implement a real-time BI system is funding. The issue with IT investments is that they tend to carry a wide range of costs. Common costs include investment in infrastructure and architecture, as well as resources that are spent on consulting, training, and support.

> *"There are a lot of initial investments before you can reap the benefits"* (OC43)

> *"... some of them are shut down because they are too expensive but others they have an appetite for"* (OC39)

One of the major cost-related assessments is around the decision to build or buy a real-time BI solution. It seems that there are a host of factors that need to be taken into consideration for this cost-benefit assessment.

> *"... we could sit and work one out ourselves and I could get a team of developers who could build one, but we'd have to weigh that up against maturing a product internally when we're retailers, we're not exactly software vendors. So it gets to a point when it could get expensive, and again, we're still building the trust across [the organization].., it takes a lot longer than 4 years to roll out a whole new mechanism of ordering through a company this size"* (OC25)

Nevertheless, costs should be transparent because they will essentially play an important role in the justification of the investment. This supports the need to identify measurable business problems or opportunities that warrant the need for real-time BI, and that can demonstrate how the costs will be paid off through the realization of tangible business benefits.

5.3 Analysis of Application Areas and Analytics

This section begins by exploring process intelligence as it was found to be the backbone of a wide range of real-time analytics. In this configuration, Business Activity Monitoring tools are widely applied. They allow organizations to monitor a variety of business metrics and also offer the ability to automate decisions. Furthermore, the use of dashboards in BAM environments is also explored. Process intelligence analytics were also found to play a large role in enabling predictive analytics as well as contributing to business process optimization. The key analytical areas that are discussed here include fraud detection, supply chain improvement, demand monitoring & forecasting, dynamic pricing and yield management, and customer relationship management. These are the key areas that are powered through real-time process intelligence analytics, and are areas that offer value through reduced costs and risks and increased profits and opportunities.

5.3.1 Process Intelligence

Research revealed that process intelligence plays a fundamental role in the entirety of a real-time BI system by providing visibility and control at the process level. For most organizations, the process level is where the bulk of their data is created. Having visibility at the lowest (transaction) levels allows organizations to garner important knowledge and can also help them to understand, monitor, and control their business processes, leading to process improvements.

> "*At our operational [process] level is where we have a need for real-time BI, and that is really where it is valuable for us.*" (A110)

Castellanos *et al.* (2009, p. 467) define process intelligence as the "application of Business Intelligence techniques to business processes [which] comprises [of] a large range of application areas spanning from process monitoring and analysis to process discovery, conformance checking, prediction and optimization". Furthermore, process intelligence can help organizations to manage performance at strategic, tactical, and operational levels by monitoring how current activities affect performance metrics and high-level objectives.

Typically, systems that produce data must be integrated and consolidated into the message-bus. It is at the message-bus where real-time data can be intercepted and analyzed.

> "*… we had to kind of build a pick-up service that runs on the tills and intercepts the transactions to bring them down*" (A45)

> "*… gets its [data] basically in real time without being impactive to various business systems*" (A18)

Monitoring this data on its own however, provides little insight. It is for this reason that historic (normalized) data can be used, in combination with real-time transaction data, to put it in context. For example, while it would be useful to know the amount items sold in one day, it is far more valuable to understand that in relation to the average number of sales for the week, month, or year. By comparing transaction data against performance indicators, which are derived from historic data, it can then be measured and analyzed in numerous ways.

> "*You can't put the traditional technology into that sphere because you will fail, you have to build this message thing and then you have operational data stores which are transaction environments that are pre the traditional data warehouse*" (A63)

> "*… allows you to pick out those exceptions. But you still have to pump that into some other environment and traditionally look at it from the master data"* (A67)

It is at the point of interception, and sometimes directly at the host systems, where process intelligence analytics and process mining techniques tend to be used. They are able to monitor and perform various analytics on real-time data, many of which are aimed at improving performance measures through process optimization.

> *"I took the Point of Sale, so the most value in terms of a retailer is that if you can see what's happening at the POS in sort of split seconds, then you know what's happening…"* (A42)

> *"So we're able to intercept those messages and react real-time into those situations"* (A57)

Furthermore, process intelligence allows organizations to have visibility and control at the process level and plays an important role in facilitating proactive responses. For instance, when a rule is breached, an alert can be generated to inform decision-makers of the problem immediately. It can also be configured to respond to situations automatically by using pre-determined business rules; this autonomy is generally appropriate for smaller (repetitive) issues which are more prevalent at the operational level.

> *"… functionality essentially is that of collecting, analysing, and then there's a workflow; all exceptions that are spewed out. It's a nice auditable workflow where every exception gets allocated to an individual to resolve"* (A27)

Business Event Monitoring (or Activity Monitoring), is one of the tools that harnesses process intelligence capabilities to facilitate the monitoring of events and activities.

"Business Event Monitor, which basically sits on top of a message bus or an ESB and allows you to intercept things in real-time" (A68)

The practice of monitoring business activity is a fundamental component in this environment. Many of the analytics that will be explored are based on the principles of Business Activity Monitoring (BAM).

5.3.1.1 Business Activity Monitoring

Business Activity Monitoring (BAM) is essentially software that is used to monitor activity as it is executed in business systems, in real-time. This kind of activity is typically derived from business processes, operations, and transactions. Through the monitoring of this data, users can make informed and timely decisions at the operational level, and subsequently help improve tactical and strategic performance measures. For instance, if a process or operation encounters a problem and ceases to run optimally, a KPI threshold is breached and BAM systems will alert users to take corrective action.

"BAM I guess can be defined as more around monitoring the actual activities that should occur and highlighting if there is a problem in terms of that business activity" (A100)

"… BAM is just another name for monitoring, it can really be used anywhere" (A102)

"… all sorts of technologies now that you can get that can assist you in identifying situations, that you can apply rules to" (A64)

Although BAM is generally applied to operational areas, it can be implemented in any areas of the business that require visibility, or that need to be monitored and controlled. At airline Co5, BAM was looking to be applied to various areas for which real-time visibility was seen as advantageous and necessary.

"You may have revenue guys wanting to know sales figures, profit, and number of seats available, the load factor (how busy the flight is), and the IT department will want to know if the systems are up etc." (A115)

BAM tools are also a useful means by which to monitor that systems are operational, communicating, and integrating. If a system is not communicating or integrating, the quality and accuracy of information can be compromised. Co3 implemented a BAM solution at their foundation layer to ensure that all the information, from which decisions are being made, is both current and valid.

> *"Let's say your BAM spans a whole lot of systems, which in many cases it does; you need to make sure that all those systems are running, talking, and sending the data across. So the foundation layer needs to make sure all is well from a systems perspective before that information can be provided to the business"* (A104)

One of the dominant features of BAM is that it allows organizations to configure key performance indicators (KPIs) which provide a means to measure and monitor business performance.

5.3.1.2 Key Performance Indicators

A KPI is the metric that is used to measure business process performance (Blickle *et al.*, 2010, p. 79). In other words, a KPI uses targets that reflect a desired state, and typically have minimum and maximum thresholds (Eckerson, 2006). Normally these are key areas of performance that need to be monitored closely. As an example, by monitoring that call centres take no longer than 5 minutes to answer calls, customer satisfaction performance is better maintained. Organizations need to identify and define their own critical areas of performance, although they are normally derived from high level strategic objectives. Co5 offered insight into areas that they are / looking into applying KPIs to.

> *"… we have what's called the metrics and the measures, those are the things that are used for KPIs. So what do people want to know in order to make decisions, like the accounts guys will want to know ROI"* (A113)
>
> *"So we do a lot of KPIs which measure your granularity of the business at a lower level, so we have a number of different types of measurements to monitor those…"* (A71)
>
> *"… want to be able to see whether our operational performance is effective; so if flights are on time, and if they're not, what are the causes"* (A123)
>
> *"… example in the Airline industry there is a big measure of on-time performances: are your planes arriving on time. As a customer, if your plane is 10 minutes late, you would consider it late. But from a [Co5] perspective and an industry perspective, anything within 15 minutes is considered on-time"* (A107)

Co3 implemented BAM at their POS in order to monitor activity at their transaction level, such as on their receipting and shelf-gap monitoring systems. For instance, if a product is receipted for an amount that is outside its threshold, it can immediately be alerted to and resolved. Similarly, if a product deviates from its average rate of sales, it can be correlated to a stock out or shelf-gap situation.

"… like receipting the stock, so if I do BAM on that I could monitor: I've got a threshold that knows that the store would never receipt more than a certain amount for lawn mowers for example. We can monitor if they've made a mistake on the receipt, which affects the stock ledger; you could do BAM to ensure that that activity is done in a disciplined manner" (A101)

It is also important to emphasize that KPIs should not be fixed; instead they must be dynamic and able to adjust. In other words, they need to be configured so that they can adjust over time, based on things like business rules and trends. For instance, a KPI measuring production time would need to adjust its threshold as the organization improves the efficiency of its production processes. This kind of configuration is ideal in a highly integrated, real-time environment, where KPIs can automatically link to business rules and historic information.

"A lot of your BAM is based on trended information, averages and accumulation of history" (A103)

"Transactional data is checked against its KPI constantly, but that KPI is determined by the information in your DW" (A127)

"You see it needs to be a dynamic KPI so that the threshold is updated once a night; continuously updated rule based on your history. E.g.: refreshed each day based on the last 12 weeks" (A126)

Organizations need to think outside the spheres of traditional BAM however, as its application has primarily been limited to monitoring quantitative data. Many organizations are extending this technique to qualitative data. For example, Co1 are utilizing business social networking data along with transaction data in order to provide more insight into indicators of attrition. This is the idea of a balanced scorecard, and it aims to give decision makers a more balanced view of business performance (Kaplan & Norton, 2008). This is done by incorporating non-financial measures in its metrics, including customer, process, and people measures (Blickle *et al.*, 2010, p. 77).

Another popular technique in monitoring data is through the application of anomaly detection algorithms. These are configured to monitor data sets and pick out oddities within them.

5.3.1.3 Anomaly Detection & Automated Alerts

Anomaly detection works by looking for outliers in data that correspond to a deviation that does not conform to regular behavior; for instance, an interruption to the workings of a process. The detection of anomalies is highly advantageous because it provides organizations with actionable information in a timely manner, and can be applied to numerous places.

> "*We're also able now … to create alerts when x or y happens; they will send an email or they can do certain things [like] send it out and alert the person*" (A97)

Anomaly detection was applied for fraud detection at both Co2 and Co4. The advantage is that when potentially malicious activity is detected, it can be addressed in a timely manner and, ideally, resolved proactively.

> *"… if an address change was affected in the last month and there is a withdrawal of money, we want an alert raised"* (A26)

> *"It allowed us to connect lines better, instead of only realizing after the fact, now you can pick up those trends a lot quicker"* (A96)

The logic for fraud detection maintains that certain events can be correlated to typical fraud risk scenarios. When detected, they can immediately be flagged and opened for investigation. Fraud systems can also identify malicious behavior by looking for unusual patterns of spending. Here, systems can actually model the spending patterns and behaviors of customers, and if there is a drastic deviation, the account can immediately be suspended (Bolton & Hand, 2002). This is an excellent example as it demonstrates how anomaly detection is valuable in environments where large numbers of transactions are generated; and it is typically here where real-time BI can offer major value.

In an environment where there is constant and numerous data, dashboards are deployed to display actionable information to decision makers. A dashboard can be described as the peak of an iceberg, where the iceberg represents all of an organization's data.

5.3.1.4 Dashboards

In essence, the dashboard is the user interface of an executive information system that is designed to display information in a manner that is holistic and easy to understand. To do so, it uses numeric and graphical representations of data such as charts and gauges (Blickle *et al*., 2010, p. 78). Information can either be "graphical, abstracted data to monitor key performance metrics, summarized dimensional data to analyse the root cause of problems, [or] detailed operational data that identifies what actions to take to resolve a problem" (Eckerson, 2006, p. 6).

"When you open the dashboard, it runs queries in the background and drills down into areas (e.g.: pie charts, bar graphs etc.) …" (A105)

Furthermore, dashboards can be configured to display customized levels of information around the organization. This means that they can be departmentalized, or even customized for a particular group of users.

"… internally, each area has dashboards" (A130)

"[we have an] executive-level dashboard, a holistic view, and then breaking that down into different divisions and departments and things like that" (A131)

"… our dashboard is like a portal dashboard, and when they click on it, it knows who the user is and what parameters they've got" (A132)

As such, dashboards can be implemented at different levels of the organization. For example, operational dashboards can be used to monitor core operational processes, tactical dashboards to track departmental processes and projects, and at the strategic level they can monitor the execution of strategic objectives (Eckerson, 2006, p. 7).

Dashboards are beneficial because they can provide users, especially at the tactical and strategic levels, with aggregated real-time information such as performance measures, targets, and trends. While their application in traditional BI environments was mainly limited to strategic and tactical level users, real-time BI is now extending their application to operational areas.

5.3.2 Predictive Analytics

There is a real need for daily decision-making at the operational level of the organization, and this is one of the areas where predictive analytics can add a lot of value. By definition, predictive analytics refers to the application of algorithms "to patterns of information about activities and behaviors that serve as a statistically valid basis for predicting potential future outcomes" (Blickle *et al.*, 2010, p. 80).

At its core, predictive analytics helps to find risks and potential opportunities. It does this by deriving patterns from a mix of live and historic data from which it can predict trends or future behavior. For decision-makers, it is highly advantageous to be able to respond proactively to predicted future scenarios. Risks can be prevented / minimized and opportunities can be maximized.

"... take what has happened in the first week and expand it out forward for the remainder of the month" (A99)

"And I think real-time helps a lot with that in terms of taking something that has happened now and then saying what will happen in the remainder of the month" (A124)

Co4 applied predictive analytics to their reporting to allow users to assess what kind of impact an event would have in the long run. This gives decision-makers an opportunity to make proactive corrections in order to optimize decisions. Furthermore, it allows them to assess the impact of a decision prior to executing it, thus allowing for the assessment of different possible scenarios.

Using prediction techniques, Co1 wants to implement KPIs that monitor predicted information so that they can monitor the likelihood of future events occurring. In other words, it is similar to applying BAM techniques to indicators that are based on predicted information. As these are delivered in real-time, it gives decision makers enough time to assess the situation and determine how it can be addressed.

"... so the ideal would be to get those indicators through and things like likelihood to leave, in real-time, then we can take proactive action" (A4)

Predicting future behavior can be a valuable asset in many ways. For example, Co3 understood that they could apply predictive analytics, on their DB of sales transactions, to assist them with demand planning. As a result, they were able to configure a solution which applies algorithms and predictive analytics to sales information in order to determine future demand. Using real-time sales transactions and derived trends, the system offers an intelligent means by which to carry out demand planning tasks.

"You purchase in cycles each year, for each season, like Christmas for example. So you'll look at the last 3 years and they do a lot of analysis on replacement items, so that's all on an OLAP analytical platform, and then it's fed into an ordering system and they order from that" (A73)

With the types of analytics that have been discussed thus far, process intelligence certainly helps organizations to monitor and take control at their operational level. Furthermore, this provides an opportunity to correct and adjust processes in order to make them more efficient.

5.3.4 Business Process Improvement

In the long run, process intelligence analytics can help organizations to actually improve / optimize their business processes. Blickle *et al.* (2010, p. 80) defines process optimization as "the practice of making changes and adjustments to a process in order to improve its efficiency or effectiveness". Logically, the idea is to reduce the amount of variation / waste in a process thus resulting in a more efficient use of resources.

With analytics such as BAM, organizations can take control of critical business processes and monitor them at a more intricate level. For instance, if a process encounters an interruption or a bottleneck, the alarms can be raised or corrective actions can be taken. Furthermore, with the knowledge of where a process broke down, measures can be taken to address those causal faults, thus improving the process. Organizations are also becoming increasingly better equipped at improving the efficiency and quality of their operations through the ability to adapt to the changing environment. Through the increasing deployment of business process automation technologies, organizations can control and optimize their processes to meet their business objectives.

Castellanos *et al.* (2009, p. 478) understand that process intelligence allows organizations to improve "different quality aspects of their business processes, either in terms of metrics meaningful to internal operations of the enterprise, or to the external customers perception". Organizations however, need to truly understand the metrics of their processes before they can begin to improve them. This is where process-mining techniques are normally applied as they can help users understand process behaviors. Organizations need to also determine which processes are critical to them; these are normally the processes that impact high-level business goals.

5.3.5 Fraud Detection

An area where real-time BI has offered a lot of value is in the fraud and forensics space; it is one of the flagships for proactive analytics. Because fraud is a time sensitive issue, if it can be detected early enough, it can be prevented. The major selling point, therefore, is that organizations can save on resources that would have otherwise been spent on recovering lost money, or ideally, they can avoid it altogether.

"… main advantages of getting real-time BI for us would obviously be the recovery, in other words, we don't have to go through expensive and difficult recovery processes if we can stop the money payout" (A33)

"So now obviously going into the more proactive mode, we can stop the money from leaving the building, which is a different ball game then" (A31)

"… we need to find a way of, in that one day, making sure that our suspicion is correct and stopping the money" (A32)

This is a good example of why real-time BI can benefit organizations by allowing them to proactively respond to situations of interest. It is important to state that real-time BI only enables this kind of environment; finding the fraudulent transactions however, is based on learned business rules. For example, Co2 applied rule learning techniques to a history of fraudulent transactions in order to discover indicators of fraudulent behavior. These are are built over time and are used to monitor data for signs of fraud.

"… often [fraud committers] … get someone inside the building that can change the address to some bogus address or something, so that when they do the fictitious withdrawal, the confirmation goes nowhere" (A128)

"… if an address change was affected in the last month and there is a withdrawal of money, then we want an alert raised" (A24)

"… look at a business process and understand where the potential fraud risk areas are and develop hypothesis around what could happen. An example could be, you're always supposed to have a segregation of duties between the person who initiates and the person who authorizes the transaction. So it's very easy to run through a set of transactions and look at authorizing and initiator; if somewhere it's the same person, and that's your exception that you would follow up on. So we've got a team that sort of builds these things … then we submit it to investigators who assist us to find the ones that are really the fraudulent ones and in that process there is some iteration of refining the code" (A30)

Fortunately, fraud monitoring software can be outsourced as there are vendors that specialize in monitoring transaction and user behavior. The system that was implemented at Co2 offered a structured and audited way to monitor data in a workflow environment where suspicious transactions are allocated to the forensics team for review and resolution. The system uses a sophisticated rules engine that scans all user activity data, in real-time, in order to find possible signs of fraud.

"… non-impactive way of getting real-time information about user behavior; essentially transactions performed by the user" (A19)

> *"… a set of rules that sort of builds by waiting [for] action. In other words, if the user does this once, we give him 10%, if he does this three times in a row, suddenly this escalates to like 90%, and our threshold is maybe at 70%. Then our alert is generated"* (A22)

> *"… functionality essentially is that of collecting, analyzing, and then there's a workflow; all exceptions that are spewed out. It's a nice auditable workflow where every exception gets allocated to an individual to resolve and the actions that they do on that are also auditable and recorded"* (A28)

A similar concept was applied at petroleum supplier (Co4), where systems monitor for fraud in the ordering process. By monitoring order trend sets in real-time, Co3 can find irregularities in those which are typical of fraudulent scenarios.

> *"… there was fraud involved with customer pick-ups, specifically at some of our depos. So that was one of the benefits for us with getting it more real-time, now we can pick up an order trend set. If they ordered [, for instance,] 45000 liters 2 hours ago, and we delivered that one, and now [they] suddenly want to come pick up"* (A95)

> *"It allowed us to connect lines better, instead of only realizing after the fact, now you can pick up those trends a lot quicker"* (A96)

It is easy to see why fraud analytics can offer organizations explicit and quantifiable benefits. These tangible benefits, which in this case are the savings from lost money and expensive recovery procedures, are crucial for the approval of a real-time BI system because they contribute towards a positive ROI.

5.3.6 Dynamic Pricing & Yield Management

When it comes to sales of products and services, prices can vary depending on certain factors and conditions. These pricing decisions are often quite complex because they have to factor many variables to determine an optimum price. In order to make the best possible pricing decision, at or near the point of sale, principles of dynamic pricing can be applied. A good example of this is taken from Co5 who explain how pricing in an airline industry works.

> *"Airlines are generally dynamically priced. For example, our booking systems are intelligent in that they can sense if the demand for a flight increases; so should the price. And it can dynamically adjust that"* (A116)

> *"… using information to make decisions, for example, we apply quite complex algorithms to determine our pricing*" (A109)

In an environment where there is access to historic information however, organizations can look to base their pricing decisions not only on demand, but also on historic patterns and trends.

> *"… we can look at the historical data and determine which days people tend to fly more, and between which destinations. That's inbuilt BI because those are the things that we know and we feed it into the systems. So we have those business rules built into the pricing system so it can decide how to price"* (A117)

> *"But it doesn't actually tell us how many seats to allocate; that's something that you need to determine. For example, when the Argus cycle tour is on, everyone is going from Johannesburg to Cape Town, so we know on those dates we will not allocate one seat to the cheapest class, we're going to charge everything to the most expensive class, because we know people will buy them. And over time you'll build those sort of ... but those have been done manually. We're implementing systems now that can monitor these things physically much better and use an automated algorithm based on information we've supplied"* (A118)

This is referred to as yield management and it is used to maximize revenue "in service industries that are limited by capacity" as they have a fixed inventory and a fairly elastic pricing scheme (Raden, 2003, p. 11). It is here where historic data can add a lot of value in making an optimal pricing decision. For instance, demand is seasonal, therefore things like passenger demand patterns, cancellations, group reservations, cargo load, and other estimates can be predicted to an extent.

> *"… we need to sometimes react in terms of when to decide to do a sale. And that will be based on how the sales are going for a flight" (*A112)

> *"So it will make sure that the pricings are adjusted and aligned with historical trends and what we're expecting"* (A119)

Retailer Co3 applied similar techniques to their own pricing system. Interestingly, they also include price comparisons as part of their pricing decision process, thus ensuring that they stay competitively priced.

> *"… we monitor our competitors and we receive those prices which we store and do price comparisons"* (A79)

> *"… you can adjust them [price] in the store"* (A78)

Therefore, where decisions are based on numerous and changing variables, and require timely execution, real-time BI offers an ideal environment in which to do so. By having access to rich historic and contextual information, along with a real-time stream of pricing schedules and evaluation criteria, the pricing process can be automated and streamlined for maximizing profits.

5.3.7 Demand Monitoring & Forecasting

Demand monitoring and forecasting allows organizations to intelligently monitor demand levels, as well as to make estimated demand forecasts. It uses both mathematical techniques, as well as real-time information from the supply chain, in order to carry out these analytics. Unlike traditional forecasting that relied only on historic data, these techniques can improve short term, and perhaps long term forecasts, through new techniques and real-time data. However, there also needs to be access to historic data from which trends and other calculations can be derived.

A good example of this is taken from Co3; they applied demand monitoring techniques in order to observe their stock levels in real-time, and make demand forecasts. By applying these techniques to their POS level, they could perform a number of intuitive analytics. Through the analysis of sales trends, they were able to monitor when their sales transactions encountered variations; these are variations that have strong correlations to stock out situations.

> "*With real-time on our till, we've been able to do things like shelf-gap monitoring, so you can monitor stock-out situations*" (A46)

> "*… you can take a subset of your goods that flow through your tills at an average rate per hour*" (A47)

> "*… if you don't see any of them going through the till, and you've had them consistently 20 per hour for 3 months, then you don't see any for 3 hours; you don't have to look at the stock ledger, you know that they have a shelf-gap situation which could mean a stock-out situation or it could just mean its sitting in stocks at the back [and needs to be brought out]*" (A48)

By knowing what the current stock levels are, what is going through the till, as well as a demand forecast, Co3 are well poised to make proactive and informed stocking decisions. To understand the benefit from a financial perspective, it is important to identify what is foregone when something is not in stock.

> "*In a retailer's world, you need to understand things like the halo effect of not having one item*" (A59)

"*So the halo effect, you might say not having a 2 litre coke for R8.50, for 2 hours, lost us this amount of money. But you didn't, you lost a hell of a lot of other business as well as a frustrated customer"* (A62)

While an organization would lose potential sales for the item that is out of stock (derived through the average sales rate × time it has been unavailable), they may stand to lose other possible sales too. A typical example is if a customer wants to buy ingredients for a meal, and the store is missing one ingredient, there is a good chance that the customer would take their business elsewhere. In this case, the retailer is not only foregoing the sales of that one ingredient, but also for the rest of the items that would have otherwise been bought. This is the halo effect.

"… [say you] go get 6 or 7 items and 1 of them isn't there you would put your basket down and go to another store" (A129)

These types of scenarios can be avoided when organizations have a sophisticated means of checking their stock levels and the ability to make calculated demand predictions. As a result, the supply chain process can be streamlined and made far more efficient.

"*… can monitor shelf-space, we could check for stock level, we could re-order immediately"* (A53)

"*… the alarms can be raised quite quickly if we know that they've under stocked a store, or we can react a lot faster with a supplier or our own distribution centers"* (A56)

"*… they can receive their stock within a 24hour period instead of a 48hour period and keep the in-stock situation higher. So the bottom line is we would be that much more profitable"* (A60)

"*…through monitoring and improving our in-stock situation, we performed well … if you look at it, it was put down to having a better in-stock situation"* (A61)

As evidence to these claims, Co3 reported that they could see higher profits by having improved their in-stock situation. The bottom line is that demand monitoring and prediction offers quantifiable benefits, which for business, makes financial sense to implement. Some of the techniques mentioned thus far were also found to facilitate improvements at the supply chain.

5.3.8 Supply Chain Improvement

An organization's supply chain is one of its core operational processes as it is the critical link between its product / service, its customers, and its suppliers (Sahay & Ranjan, 2008, p. 37). Although every company has a supply chain, only some manage theirs for strategic advantage. Part of the reason is that a supply chain becomes much more complex the larger the organization, its range of products / services, and the more distributed its customers, suppliers, and distribution centres are.

While improving a supply chain is not a simple procedure, it can have very rewarding benefits because it typically represents such a large portion of an organization's cost structure. To do so, organizations need to understand how they can leverage technology to minimize operational costs (including manufacturing, transportation, and distribution), and help optimize inventory storage and placement. Because these are process-centric activities, a real-time BI environment is a perfect platform to do this. A study by de Oliveira, McCormack and Trkman (2011) looks at the impact that business analytics has on an organization's supply chain and confirms, from a sample of 788 companies, that there were significant improvements in areas such as planning, sourcing, making, and delivering.

At the distribution level, petroleum supplier (Co4) understood the importance of improving the efficiency of their logistics. With a network of over one thousand petrol stations, within Sub-Saharan Africa, and a host of other customers, Co4's logistics management is a complex task. Many of these processes however, can be improved in a real-time environment (Blickle *et al.*, 2010, p. 61). By monitoring various aspects of their logistics and distribution process, Co4 were able to better understand their processes, and make essential improvements.

> "*… is that product going in via pipeline, via rail? … So we're looking really at the type of products and then the mode of transport"* (A84)
>
> "*… we're looking at volume and turnover and looking at that by-product via mode of transport"* (A82)
>
> "*… a big focus in our supply chain into Africa, so we're looking at moving of product from South Africa into [Country A] for example, wanting to understand what is our transport time by boat from here to the harbor in [Country A], what is our delay time, their harbor time, offloading, transporting …"* (A87)
>
> "*… so we want to get an idea in terms of timing, moving of product, in terms of cost incurred, in terms of cost associated with delays …* (A88)

Although still in their early stages of improving these processes, Co4 have implemented metrics to monitor distribution timing, volume, turnover, and cost along their various modes of transport. By monitoring these metrics in near-real time, Co4 can make informed decisions that can help cut costs through better inventory management, storage, and transportation.

On the production side of the supply chain, which is typically a process dominant function, Co4 demonstrate how they applied process analytics to optimize some of these activities. These complex sets of production processes can not only be automated, but when interruptions occur, they can be alerted to immediately so as to minimize their disturbance. Because production is a progressive process, where processes are dependent on each other, an interruption can easily disturb the entirety of the output and lead to bottlenecks and variability. This is an inefficient use of time and resources and can be avoided through sophisticated monitoring and control. While some of the configurations are simply time-based, the system makes use of business rules that monitor the status of processes in the production lifecycle.

> "*... when you talk automation, we use a Production Scheduling System (PSS)*" (A92)

> "*we use a Production Scheduling System (PSS). Some of these PSSs are event-based, so its saying when the ... runs kick off this set of transactions. The other is time-based"* (A93)

While increasing efficiency at the production and distribution level can significantly cut costs, it is important to understand that the supply chain should be optimized at the retail side too. It is here where organizations can plan for inventory demand; a technique that can help reduce costs and still meet demand. Unfortunately, many organizations are reluctant as they believe inventory optimization comes at the expense of customer service (Gupta, Maranas, & McDonald, 2000).

With access to current and historic information, trends and forecasts can be used along with demand planning systems to calculate how much inventory to order. This for example, is an area that Aviation Company (Co5) is looking to apply to their on-flight catering. This is because one of Co5's airlines operates on a cash service so they need to make calculated predictions on how many different types of meals to supply.

> *"One of the main areas where we're looking at is at the catering side, on the [Airline A] side, catering is simple because if 20 people are flying we know to provide 20 meals. With [Airline B] however, it becomes harder because it's a cash service, you*

have a difficulty of understanding how much product you have on board because you don't know necessarily how much people are going to utilize" (A120)

Although Co5 could over cater their meals to satisfy demand and keep customers happy, it would not be an efficient use of resources as these are perishable goods, and are therefore likely to result in waste. With better demand planning however, organizations can cut down on these kinds of costs.

For retailers like Co3, it is not only about being able to accurately predict what the demand is likely to be, but also about knowing how much inventory they have at the current time. With their real-time POS able to monitor each transaction as it happens, they have the means to monitor that against how much stock there already is in the store.

> "*… for retailers, that's a massive advantage to understand, centrally, what your shelves look like and then measure that and also re-organize your supply chain*" (A49)

Co3 believe that it is not only important to meet demand, but to meet the right demand. As such, they applied intuitive analytics to understand how they should be distributing their products across their countrywide outlets.

> "*… category management, where you look at like your pet food at different stores across the country and you start to change your range of items depending in the sales and the type of customers*" (A75)

In other words, by analyzing the sales of groups of products, at a higher level as well as at the product level, allows for a more optimized placement of products according to factors such as customer demand, region, and availability.

In light of this, by having better visibility at the supply chain, whether production, distribution or retail, organizations can learn to improve many of these processes. Because the supply chain typically represents such a large portion the cost structure, an improvement can almost certainly translate into significant financial rewards. By improving these critical processes, costs can be reduced which directly affect the bottom line. Furthermore, these improvements help to create a more demand-driven supply chain.

5.3.9 Customer Relationship Management

Customer relationship management (CRM) is a commonly applied practice that is used to manage the interaction between an organization and its customers, clients, as well as sales prospects (Goldenberg, 2008). It primarily serves to find and attract new customers, retain existing ones, as well as reduce the costs of marketing.

While it is not a new practice, advances in real-time BI application have found to help manage, automate and synchronize many of these business processes. This helps organizations to take advantage of real-time customer relationship management opportunities. Although they typically include sales activities, they are also applied to marketing, customer service, and technical support functions (Goldenberg, 2008, p. 3).

In this research however, CRM was only briefly mentioned and will therefore only be explored at a surface level. An area where its application is growing is in Co3's online space where marketing activities are being applied by reacting, in real-time, to user behavior.

> "*… [the] money market, which you can make all sorts of payments like electricity payments, and [the ticket booking system] are linked into that. So we're able to intercept those messages and react real-time into those situations"* (A58)

By monitoring user activity, things like marketing messages, offers, information, and support can be better tailored for their audiences. More so, organizations are able to better understand consumer behavior and consumer needs; and are therefore equipped to offer them value.

For example, Aviation Company (Co5) wants to understand, measure, and monitor various aspects that drive their consumers. Because they operate in a highly competitive environment, knowing what consumers want and being able to offer it to them can help retain and attract customers.

> "*... we're looking to apply it from a marketing perspective, to really understand our customers, what they want, their behavior, and the customer experience"* (A121)

> "*We want to know what drives them [customers], because in our environment you can compete on price only to a point. There's only so low I can charge until it becomes un-profitable to do business. So we want to see what drives our customers to us, what surrounds the customer experience and can we measure those aspects of the business"* (A122)

The ability to offer consumers relevant value is the key driver behind customer facing real-time systems. They do this by allowing organizations to react to activities, as they happen in real-time. With real-time CRM, organizations can apply event-driven marketing practices, process automation, and BI all together. It is essentially a way of getting information out as quickly as possible, making decisions quickly, and monitoring the current state of the business. Having a means of understanding consumers and being better equipped to offer them value is therefore another way that organizations can increase profits and gain strategic advantage.

5.4 Analysis of Users

This section analyses various aspects of the real-time BI user, namely data and latency requirements, training, resistance and adoption, and how decision-making is affected at different levels of the organization. It was found that users at strategic, tactical, and operational levels require different types of information, at different latencies. It seems that demands for lower latency data increase the lower the organizational level, with operational users requiring access to more current data. Furthermore, efforts need to be put into adequately training users so that they are capable of utilizing these systems. Another area of concern was user resistance, which had been noted several times; managing this is key to effective adoption. Finally, decision-making was found to extend to the operational areas in a real-time BI environment, thus encouraging micro decision-making and also providing more responsibility at lower levels. It also facilitates more proactive decision-making, and in some cases it can be automated.

5.4.1 Data Requirements

Real-time BI users at different levels of the organization are likely to have different information requirements as well as different data latency demands. For this reason, it is important to understand these requirements in order to ensure that users can be furnished with the right information, in the right format, at the right time (Ioana, 2008).

Often, data requirements can be derived directly from high-level strategic objectives. Say for instance an organization wants to grow its market share by x%. At a tactical level, this could translate into something tangible such as the need to see growth in product groups a, b, c by y%. That can then be further transformed into operational measures, for example, the need to improve customer satisfaction, improve on-time deliveries, and improve the in-stock situation by z%. Although this is a hypothetical example provided by Co3, it shows how information requirements at different organizational levels can be derived from a high-level objective.

> *"… there's a whole breakdown of how that main indicator [high-level requirement], that sits at the strategic level, then becomes an operational measurement"* (U31)

At a strategic and tactical level, information requirements are typical of traditional BI. The former focuses on reaching long-term objectives (strategic goals). As such, those users want to analyze the organization's performance in areas that directly affect the objectives. The analysis is therefore done on data with a much higher temporal window, such as weeks or even months; this is mainly historic data. Similarly, at the tactical level, the focus is on reaching tactical objectives which are defined around the strategic goals. At this level however, the data latency is normally within days and also requires historic data.

In contrast, operational / real-time BI seeks to provide visibility into the current state of operations; therefore the required latency of data is much lower, often in terms of minutes or even seconds. For example, in order for operational managers at Co3 to see current stock levels, they require low latency transaction data. Due to the nature of operational BI, users should also be able to create their own KPIs and then actively track them. This too requires historic data for trend analysis.

> *"... you need to bring that real-time, and you have to put it in context with historic data from the warehouse; the history defines the future. Transactional data is checked against its KPI constantly, but that KPI is determined by the information in your DW"* (U35)

Furthermore, operational users want to be able to make fast decisions, spot emerging trends, and immediately take action when problems arise. It is evident that information and latency requirements will therefore vary depending on the level of the organization, and the type of user.

At Co1, an executive-level dashboard was implemented at the strategic level in order for management to have a holistic view of their high-level indicators. This allowed high-level indicators to be broken down further into organizational levels so as to provide relevant information to its respective audience.

> *"... [the system ensures that] senior leadership [looks at] the trends across the business and the operational levels will look at their regions and areas"* (U5)

> *"... break that down into different divisions and departments and things like that"* (U4)

> *"... how satisfied are people in different regions, what are the trends, and what's causing that"* (U7)

In order to understand these requirements, it is important to include users during the planning stages of the project. In doing so, user-specific information requirements can be understood and documented; thus ensuring that they are not overlooked. For instance, forensic analysts at Co2 require specific contextual information when they are alerted to a fraudulent transaction.

> *"Typically you need the transaction data (the payment transaction) and something about the policy, the policy owner ... at times you need inception data"* (U14)

"... often the forensic analyst would require all available transactional data and geographic data from a business area" (U15)

Understanding data requirements is not a once off task. As business circumstances change, so do users' information requirements, and the BI function needs to adapt to this appropriately. Co3 performs BI on its own BI in order to see what information is being pulled, where it is being used, and how it is being used (U32). This helps the organization develop a better understanding of information utilization. This subsequently enables the organization to configure the type of information it makes available to its users.

In light of this, before implementing real-time BI, it is important to assess various information requirements of the users. While strategic objectives are a useful starting point for this, it is also crucial to include the user during the planning stages of system design. Similarly, it is important to consider whether the real-time information that will be provided to the user will be understood. Organizations may need to look into training their users to ensure that they have ability to make use of the system.

"*... if you had an audience that won't understand information that is constantly changing"* (U38)

5.4.2 Training

The introduction of new systems typically warrants the need to train the end-users; real-time BI systems are no exception. One of the reasons is that the data is modified much more frequently than traditional BI data. This requires that users are trained to understand how to make sense of it, as well as how to interact with it.

"Analyzing data is also different to the traditional BI environment, and so the users should be adequately instructed" (U39)

While traditional BI was intended for the strategic and tactical audience, where systems were designed mainly for analysts and power users, real-time BI extends to operations level users who may not be familiar with these concepts (Ioana, 2008). This is because operational users may lack the skills to use BI tools.

Without adequate user training, Co4 warns of the risk of failing to fully utilize the benefits of the system. In addition, it could compromise how effectively the users are able to actually do their jobs. This could even lead to project failure which is a detrimental outcome to an organization as a whole.

"… making sure that people understand what it is they're looking at and to make sure they are truly ready to receive what they're looking for" (U40)

Although training was only raised briefly in this research, the field of information systems recognizes it as a very crucial component of system implementation (Vankatesh, Morris, Davis, & Davis, 2003). Training is certainly a stepping-stone towards system adoption, failing to do so could be detrimental to the success of the project.

5.4.3 Resistance, Participation & Adoption

Whilst there are many reasons for users to show resistance towards adopting a new system, in this research, it generally stemmed from change brought about by the introduction of the system. At Co3, a policy was introduced alongside the system that aimed to maintain the quality of data by holding users accountable for their data. As a result, users felt more hesitant about the system because they would have the burden of carrying additional responsibility.

"… they're often quite resistant to that because you're making them responsible for the quality of their data" (U19)

At Co3, operational staff were not accustomed to using information to make decisions for day-to-day activities. In light of this, adequate change management had to be deployed in order to assist them in this transition.

"It's been a process of getting them to accept looking at a screen when they assess the situation in terms of their business; it hasn't been their culture" (U23)

Co3 also believe that it is important to be cautious when deciding how real-time information is distributed to the user. Their ideology espouses the belief that large quantities of frequent data can be disruptive and discourage adoption by the user (U25). Thus information is made available but is not forced on the user.

"… [ensure] that you're not creating more headaches by introducing more frequent information rather than what they were used to" (U33)

A common cause of resistance is often due to a lack of familiarity with system design features and poor usability. If a user is required to learn a completely new system; it is likely to negatively affect their eagerness to adopt. In light of this, and in order to make adoption easier for the user, Co1 adhered to the principles of familiarity while developing their system. The SDERMS was designed in a way that harnessed principles of existing social-networking design concepts that most users were already familiar with. As such, users did not have to learn an entirely new system which made adoption easier and utilization higher.

> *"... we're quite a young profile as an organization. So most people here would be active on things like Facebook and those kinds of sites; so social-networking, they're very familiar [with]"* (U8)

> *"... the idea of a homepage and a feed and that kind of thing ... has made it more attractive, so there is a very high utilization rate of the system"* (U9)

In addition, to increase participation, Co1 also consolidated other frequently used functionality into the same system; such as applying for leave.

> *"... you also [do things like] apply for leave on the system"* (U10)

Interestingly, at Co4, the introduction of performance contracts was also found to contribute towards participation with the system. With contracts in place, users were found to be more proactive in their work in order to meet their requirements. With real-time BI, which facilitates proactive and forward-facing reporting, they had the tools to do so and were therefore utilizing the system more.

> *"... the introduction of a performance contract ... you now have people wanting to be a whole lot more proactive"* (U29)

With forward-facing reporting, users can utilize past occurrences to forecast projected values for the remainder of the month and understand what changes need to be made. Thus, performance and performance objectives can be changed in advance to meet predetermined targets (B48).

It is evident that the introduction of a new system in an organization means that users have to undergo change. How well that change is managed can determine how well the system is adopted by its users. Change management is therefore a highly important task. If organizations can manage this process, they can help minimize resistance and subsequently facilitate adoption.

> *"... the main challenge was transformation management, so [a] paradigm shift"* (U28)

5.4.4 Decision-making

It is also important to look at how users' decision-making will be affected when real-time information is introduced. While real-time BI facilitates decision-making in several ways, its application in the operational level is particularly noteworthy. While strategic decision-making relies mostly on historic data analysis, users can combine current and historic data to configure and track live KPIs. As such, users can monitor how performance measures affect high-level strategic and tactical objectives, in real-time. They can then make critical and timely decisions to make corrections when and where they are needed.

It is at the operational level however, that real-time BI offers users most value in terms of decision-making. Due to the pressures of the competitive and changing business environment, operational level users want to make faster decisions, spot emerging trends, and take immediate action when problems arise (Ioana, 2008). In contrast to traditional BI, decision-making touches a bigger number of users in a real-time BI environment, namely at the operational level. While KPIs were only available to strategic and tactical decision-makers, real-time BI extends this to the operational level. As a result, operational decision makers are better equipped to drive both tactical and strategic objectives.

Co3 witnessed an increase in decision-making at operational levels, where increasing numbers of users were starting to use information to make decisions. This also increased the responsibility of users at this level. Further, decisions can be taken faster without having to refer every decision to a superior.

> *"… there was very little micro decision-making on stock and replenishment [before real-time BI]. So the last 7 or 8 years has completely been turned on its head. There's a lot more responsibility at lower levels"* (U34)

> *"We have users at grass-roots level"* (U21)

Several organizations also spoke of using real-time BI to enhance their decentralized decision-making. When a situation of interest arises, which requires user intervention (decision-making), it can be allocated to the appropriate user(s). Decentralized decision-making can be described as the distribution of decision-making authority throughout a larger group (Kumar & Takai, 2009).

> *"… when information happens, those things can be sent out to alert and say: there's a trend that's just happened, [who do] you want it to be alerted to? And so your audience gets alerted to that"* (U27)

> *"… every exception gets allocated to an individual to resolve"* (U12)

One of the major selling points of this is its ability to furnish users with up-to-date information, forecast alerts, and exceptions, prior to a situation occurring. This early-warning method allows users to proactively make decisions when situations of interest arise. This allows potentially problematic situations to be minimized before they escalate. And, similarly allows situations of interest to be harnessed early to maximize the value of their potential benefit.

With real-time BI, decision-making is becoming more automated, especially at the operational level where common and repetitive decisions are made. As a result, users are able to streamline their decision-making as well as better equip themselves with information when a decision needs to be made. By providing relevant, accurate and timely information to the correct audience, along with techniques such as alerts and automation, organizations can significantly streamline and improve the efficiency of their day-to-day decision-making.

5.5 Analysis of Benefits

This section illustrates the benefits that were realized through implementation of real-time BI. Firstly, with access to real-time business information, decision-makers not only have unified business visibility, but that visibility reflects the current state of the business. It was also found that real-time BI facilitates decentralized decision-making which was found to increase micro decision making and responsibility, particularly for users at operational levels. Furthermore, as more information becomes readily available and easier to analyze, organizations often start to discover things that were previously not visible. The benefits of predictive analytics were also discussed, whereby organizations can predict the likelihood of future events occurring. This allows them to address potential risks or opportunities in a proactive manner. One of the core advantages is the ability of real-time BI to drive business processes thereby supporting the transition of information into action. Furthermore, adaptive systems can sense, interpret, predict, automate, and respond to business events; this is fundamental in maintaining performance in an ever-changing business environment. As a result, this allows organizations to better optimize their business processes. Ultimately, these benefits are helping organizations to decrease costs and risks, and increase profits.

5.5.1 Real-time Business Information

One of the main priorities of real-time BI is to deliver information at the right place, at the right time, and to the right people (Ioana, 2008). Decision-makers have far more business visibility in an environment where business systems are integrated and enterprise-wide information is accessible, accurate and current. Furthermore, because performance indicators are refreshed with real-time data, the current state of the business can be monitored. For decision-makers, these are core competencies.

> "*… there's a lot more visibility of what's happening in the business*" (B30)

> "*So that whole thing, and obviously there's lots to learn, I mean as you move, and are now receiving information you can monitor with real-time, you start to learn more about the business because you get different visibility on the business*" (B18)

Co3 reported an increase in decision-making at operational levels, where more users are beginning to use information to make decisions, and subsequently take on more responsibility. Furthermore, decisions can be taken faster without having to refer every decision to a superior; thus encouraging more decentralized decision-making.

> *"… there was very little micro decision-making on stock and replenishment [before real-time BI]. So the last 7 or 8 years has completely been turned on its head. There's a lot more responsibility at lower levels"* (B59)

"… when information happens, those things can be sent out to alert and say: there's a trend that's just happened, [who do] you want it to be alerted to? And so your audience gets alerted to that" (B60)

In addition, the deployment of dashboards allows for KPIs to be implemented which are useful for monitoring organizational performance. By having visibility over KPIs, as they are refreshed with a live feed of data, organizations are poised to make timely and objective decisions, and can assess their impact on business performance.

Unlike traditional BI, the fundamental advantage is that visibility with real-time BI is current and reflects an accurate enterprise-wide state of operations and indicators of performance. Through this, organizations can analyze how changes in performance indicators are affecting high level business objectives, and can make necessary changes when they are required.

"*… they're able to see what's happening in the business long before they get the financials at the end of the month or year*" (B32)

Moreover, real-time data can be contextualized as it is trended with historic data, giving decision makers an enriched insight for making informed decisions. Monitoring data at its source is advantageous because live data is actively incorporated into the decision making process.

"… you need to bring that real-time, and you have to put it in context with historic data from the warehouse; the history defines the future. Transactional data is checked against its KPI constantly …" (B54)

Organizations are required to make timely decisions, in an environment that is characterized by rapid information and changing conditions. Real-time BI certainly addresses the need for current and quality data that facilitates decision-making in quantifiable ways. Furthermore, having better business visibility offers somewhat of a ripple effect where organizations can start to monitor, learn, and subsequently improve their operations. For example, when Co3 enabled real-time POS, they started to learn and discover new things that they previously had no visibility over. They could see what their shelves looked like, in terms of stock levels, at any given time. For a retailer, having this kind of visibility is of substantial advantage.

"*… for retailers, that's a massive advantage to understand, centrally, what your shelves look like and then measure that and also re-organize your supply chain according to those performance measurements*" (B15)

"*... it gave us an insight into the business, not only in shelf-gap things, but also in the way we pack our goods away, the way we replenish the shelves, the type of things we use in terms of gondolas and stuff in the stores, the type of shelf space*" (B16)

Having visibility across the business is therefore certainly a value adding factor of real-time BI; but it also has several other benefits. For instance, it makes new information available which aids the process of learning and discovery.

5.5.2 Learning & Discovery

By starting to monitor areas of the business, such as at the process level, that were not possible in a traditional BI environment, new information is made available. It is this information, which previously was not visible, that aids organizations in learning and discovering new things. In addition, it allows organizations to do a lot more with their information, such as making improvements in key business areas.

"… *you know more and more as the information becomes more readily available*" (B42)

"... the new information that will give us a handle on what is happening in areas that we never saw before" (B11)

"… *there's lots to learn, I mean as you move, and are now receiving information you can monitor with real-time, you start to learn more about the business because you get different visibility on the business*" (B18)

"... some of the transactions previously were invisible and are [now] visible" (B9)

Co3 have gone from auditing the service levels of their suppliers at a high level, to a much more thorough and precise manner. Formerly, the retailer would measure service levels from a receipting point of view by checking whether the value of their order matched an expected range of value received. Through monitoring transactions at their POS, they are now able to audit their orders down to the specific derivatives of products, ensuring that they have received the correct quantity and range of product groups. This not only keeps the customer happy, but also maintains better service levels.

"... so they're able to make global strategic decisions about suppliers, supplier negotiations with discounts. A lot of that information wasn't really available ..." (B34)

> *"A lot of that information wasn't really available … they [used to] look at contracts or receipting of stuff from the supplier rather than what's actually happening on the till … We've got about 8000 suppliers but 150 are what really make up the company … So you've got to monitor those 150 very closely in terms of their service levels. We don't even measure service levels based on value orders to value received, but down to the derivatives of the items we order"* (B59)

Co2 report that their forensic team can now monitor every transaction made by a user. By monitoring user behavior through their transaction data, the forensic team reported to having a better understanding on what syndicates may be doing within the business. In terms of forensics, this is particularly advantageous from a security point of view.

> *"… this tool brings us new pieces of information that previously wasn't visible, so if we want to understand what syndicates might be doing in the building; it's got a new way of focusing on that"* (B8)

> *"But the biggest win for us is more the new information that is coming to the fore so that we could look at what syndicates are doing, so that was my biggest driver"* (B10)

Organizations can therefore garner important business insight and discovery from the new information that is available to them. By doing so, they stand to make significant improvements to key business areas.

5.5.3 Prediction

Prediction, in a real-time environment, is a powerful tool for decision-makers as it can estimate the likelihood of future events occurring. Prediction makes it easier to decide what course of action is best at the current time, given the current circumstances. Both live and historic data are used to derive patterns and algorithms which can then be used to predict trends or future behavior. This is useful to organizations because it can predict risk and/or potential opportunities. As such, risks can be minimized or even prevented, and opportunities can be maximized.

For example, at Co4, users are able to take an event and project its effect forwards in time to see what impact it is likely to have. Thus, instead of receiving a report that shows what has already happened, it is now geared towards saying what is likely to happen. This is particularly useful for users at Co4 who are able to proactively make changes to ensure that they achieve the performance targets required by their contracts.

"... reporting has also changed from being backward-facing to being a whole lot more forward-facing ... saying what is going to happen" (B47)

"... take what has happened in the first week and expand it out forward for the remainder of the month. It allows people to be a little bit more proactive in that they can see that, if they continue on their current trend, they will not achieve their budget and therefore not reach the target in their performance contract" (B48)

"It allowed us to connect lines better, instead of only realizing after the fact, now you can pick up those trends a lot quicker" (B44)

Furthermore, it allows them to assess the impact of a decision prior to executing it, thus allowing for the assessment of different possible scenarios; like a what-if analysis. This gives organizations the advantage of being forward-facing and proactive.

5.5.4 Proactive Responses

Traditional BI was used for historic analysis of information that was geared towards reactive decisions. In contrast, real-time BI can alert users prior to a problem occurring so that it can be addressed proactively. By identifying anomalies early, problems can be addressed before they can be of detriment. This is a proactive response, and is a prime example of how real-time BI aids organizations in being forward-facing, efficient, and able to minimize the impact of potentially detrimental situations.

For the forensics team at Co2, taking a proactive stance against fraud is a key success factor. Prior to implementing their real-time fraud system, the team could only discover fraudulent transactions during audits (after-the-fact). Resources would then have to be spent on recovering lost money in a reactive manner.

"... now we're trying do proactive forensics ... which is sort of a new kind of focus" (B5)

"So now obviously going into the more proactive mode, we can stop the money from leaving the building, which is a different ball game then" (B6)

"... main advantages of getting real-time BI for us would obviously be the recovery, in other words, we don't have to go through expensive and difficult recovery processes if we can stop the money payout" (B7)

With proactive forensics, Co2 are poised to address situations of concern before they can escalate. This minimizes the impact of conducting recovery procedures by stopping money payouts as they are caught in real-time.

Similarly, Co1 aims to proactively alert the organization when there are predictions of attrition (an employee's likelihood of leaving). By doing so, they have time to follow it up, and if their predictions are correct, corrective actions can be taken to help prevent it from happening.

> *"But that's all after-the-fact, so we can make some changes afterwards but it's all reactive and so the ideal would be to get those indicators through and things like likelihood to leave, in real-time, then we can take proactive action"*(B2)

> *"… we'd like to get to is a more predictive situation which would be more real-time analytics"* (B1)

Airline Company (Co5), although in their early stages of BI, want to leverage real-time proactive alerting at their operational level where they can respond to operational issues. For example, predicting the likelihood of a flight delay would allow them to proactively take measures to minimize the impact of such a situation. In this example, they could proactively expedite operational services such as gate control and baggage collection to the delayed passengers.

> *"At our operational level is where we have a need for real-time business intelligence, and that is really where it is valuable for us. For example we want to see if a flight is delayed so we can react immediately"* (B50)

Just as negative situations can be minimized, proactive responses are also used to maximize opportunity. For example, Co5 explain how they use proactive pricing decisions to adjust their ticket prices to maximize value from their sales.

> *"I know I can find 20 people willing to pay R100 for a seat and 30 people willing to pay R200. That's the trick in the airline industry is to find those people. But sometimes, if your calculations are not right you are actually forced to change it, so if you didn't meet the numbers you'd have to increase the number of R100 seats and decrease the number of R200 seats. That's called revenue management. So you need to be able to proactively adjust the price to the right curve"* (B53)

With the ability to determine the right price, depending on the sales of tickets at different classes, they can adjust the price accordingly, in real-time, so as to gain the most potential value. In essence, real-time BI allows users to change from reactive to proactive responses. They are able to see critical indicators of performance, in real-time, or even predict potential outcomes. Real-time BI however, also facilitates major improvements from a systems perspective by allowing business processes to essentially drive themselves.

5.5.5 Automation and Adaption

With the increasing need to make faster decisions, the ability of business processes to drive themselves is seen as a major advantage as it supports the transition from information into action. Real-time BI is closing the loop between operational systems and BI in order to reduce action (response) latency (Melchert *et al*., 2004). Systems are able to monitor data, as it is executed in real-time, and can be configured to automatically respond when certain conditions and exceptions are found.

> "… *as it flows through your message-bus it can pick out stuff and you can look for certain conditions*" (B27)

Decision-making is becoming increasingly embedded into the normal business workflow whereby systems are able to automatically sense conditions / identify problems. They can then make near optimal decisions and propagate actions based on the best knowledge available; all with little-to-no human intervention. This however, does not suggest that there is no role for decision-makers as often they are forced to review critical decisions.

For Co3, an area where self-made decisions are gaining popularity is in the stock ordering process. Currently, stock levels, sales, and trends are fed into a system which uses complex formulas to predict what should be ordered to maintain stock levels. This happens automatically and is able to dynamically adjust its predictions when any of those variables change too. Generally, the order predictions are placed automatically, with the exception of a few stores where stock management is manual, and decisions must be reviewed (B55). Ultimately, this not only saves store managers the time they would take to compile and initiate stock orders, but it makes the process much more efficient. Although the benefit of this is quantifiable, Co3 stress that it has been an obstacle in terms of gaining approval from the business.

> "… *auto-prediction itself, in terms of implementation, not from a systems perspective, but from a perspective of change-management with people and the trust of those predicted orders is quite a slow process*" (B21)

While not all decisions can be automated, those which are routine, especially at the operational level, certainly can be. Those that are based on a predefined set of variables, where a certain degree of flexibility is allowed, are particularly suitable for this environment. A good example is dynamic pricing. Airline Co5 explain that ticket pricing is based on multiple variables such as passenger demand patterns, seasonal demand, customer loyalty, cancellations, group reservations, and cargo load. These pricing decisions are therefore complex because they have to factor in many variables to determine the optimum price, given the circumstance at the current time.

> *"Airlines are generally dynamically priced. For example, our booking systems are intelligent in that they can sense if the demand for a flight increases; so should the price. And it can dynamically adjust that"* (A116)
>
> *"… using information to make decisions, for example, we apply quite complex algorithms to determine our pricing*" (A109)
>
> *"So it will make sure that the pricings are adjusted and aligned with historical trends and what we're expecting"* (A119)

In order to make the best possible pricing decision, at or near the point of sale, principles of dynamic pricing can be applied. This is because many of the variables can be estimated using predictive analytics and analysis of historic data, whilst others, such as demand, can be derived through analysis of real-time data.

While automated decisions are not a new concept, advances in real-time BI are offering more "intelligent" means to sense changes in the environment and offer rapid responses using rules and algorithms. This can be described as adaptive behavior. Adaptive behavior, although not explored in depth in this research, is becoming increasingly important in today's dynamic and ever-changing business environment, where managers are expected to deliver important strategic decisions, with an ever-increasing load of information (Michalewicz, Schmidt, Michalewicz, & Chiriac, 2006).

A decision is generally based on two fundamental questions: what is likely to happen in the future, and what is the best decision right now? (Michalewicz *et al*., 2006, p. 55). An intelligent system should therefore be able to predict the most probable future circumstance and automatically take appropriate action based on that prediction. With the ability to adapt, the necessary measures are taken to align the organization in meeting its desired objectives, in a range of environments. The structure in a real-time BI environment allows data to flow from processes, through analysis tools, which can then turn data into information and into action by propagating targets back to the process layer (Azvine *et al*., 2005). Furthermore, with automation and adaptive behavior at the helm, real-time BI systems are increasingly aiding in the improvement of business processes.

5.5.6 Business Process Improvement

Organizations are increasingly becoming better equipped at improving the efficiency and quality of their operations with the ability to adapt to the changing environment. Through the increasing deployment of business process automation techniques, organizations can improve and streamline their processes to help meet desired performance targets and business objectives. According to Vitantonio, Legh-Smith, Millar and Wilkinson (2006), a key factor in creating an adaptive organization is to ensure that its processes and applications are built on an infrastructure that is itself adaptive.

With analytics such as BAM, organizations can take control of critical business processes and monitor them against performance measures and business objectives. For instance, if a process encounters an interruption or a bottleneck, the alarms can be raised or corrective action can be taken automatically to allocate resources to the problem area(s).

> "*…BAM (Business Activity Monitoring) to ensure that that activity is done in a disciplined manner*" (B56)

> *"… monitoring the actual activities that should occur and highlighting if there is a problem in terms of that business activity"* (B57)

In light of this, real-time BI makes available the tools that can improve business processes through the ability to adapt to the internal and external environment using intelligent control mechanisms. Productivity improvements at the operational levels are, in the long-run, likely to therefore result in increased profits.

> "*… the bottom line is we would be that much more profitable*" (B58)

An example of this is supply-chain improvement, which is one of the main focuses at Co4. By improving the efficiency of the processes that make up the supply chain, Co4 stand to make significant financial improvements. This is because the supply-chain typically represents a large portion of an organization's cost structure. Although they are in their early stages of doing this, metrics were implemented to monitor things like distribution timing, volume, turnover, and costs associated with various modes of transport. Through monitoring these in real-time, and making necessary changes as more is understood, Co4 can significantly cut costs and increase efficiency of inventory management, storage, and distribution.

Although business process improvement was not directly addressed in the research, the outcomes of real-time BI implementation have suggested an improvement at the process, and overall operational level of the organization.

5.6 Analysis of Investment Process

This section explores details of the investment proposal and justification of real-time BI. Firstly, a general investment process overview is described which emphasizes the need to identify drivers of the investment (business problems / opportunities), to conduct market research, and also details around the building of a business case. The various stakeholders involved in the venture are then examined; these include executive stakeholders, particularly from the business area(s) being affected, and those who are involved in approval of the project. The importance of including both IT and business stakeholders is also stressed. Further, organizations must decide whether they are going to build or buy real-time BI solutions; findings show that it is generally cheaper and less time-consuming to buy, unless there are adequate development skills available in-house. When buying, vendors should be assessed in terms of maturity, IT skills, and availability of support. Because business may not necessarily understand required investments in technical components, they need to be trusting of IT expenditure. On the other hand, IT needs to earn trust from the business by consistently demonstrating value from their investments; one way in which they do this is by being conservative in their ROI projections. Furthermore, the importance of identifying business benefits, both tangible (measurable) and intangible, and their role in justifying the cost of the real-time BI investment (ROI) is discussed here. Lastly, it is advised that organizations invest in architectures that can support the business in the long-term by being flexible, scalable and capable of configuration.

5.6.1 Investment Process Overview

As a starting point of the investment proposal, as mentioned previously, it is vital to first identify measurable business problem(s) or opportunities which real-time BI can address. These are the business requirements and they form the crux of the business case and ultimately drive the proposal.

> "*… not too difficult to come up with a business case for our particular needs*" (I5)

> "*Whenever any IS investment decision [is made], like … an investment into a specific project that will bring new functionality on board for example, all of that gets placed in the business case, before the decisions are made around whether to proceed or not*" (I71)

During these early stages, it was suggested for organizations to conduct market research for exploring what is available on the market; in areas like technology and analytics. Regardless of whether the decision is to build or buy the solution, market research is an important part of the process and should certainly be looked into.

"*… the first port of call, [for us], is can we buy it? … and when you do that research, it's a very good learning curve, you send out a request for information (RFI), you learn a lot from what's in the marketplace and you can pick up ideas which assist you*" (I48)

After reaching a decision, it needs to be placed before a business case. Common components of a business case include background to the project (the problem areas that are being addressed or value being harnessed), the anticipated benefits and how they will pay the investment off, potential options if there is more than one solution, the cost, the risks, the high-level business implications, and potentially an implementation plan. Additionally, Co2 reported that technical approval was required in conjunction with requiring a business case for financial approval (I30, I31).

"*… you need to have a strategy and your budget, what you're going to spend on infrastructure (which they might not understand), and then there's got to be real benefits from that*" (I56)

"*[for example], we have to invest in a new foundation or a new integration platform; these are all the different benefits we will deliver over the years*" (I52)

Some organizations were found to have started off with smaller investments. These subsequently had smaller and simpler business cases that were then evolved and iteratively matured into real-time BI.

"*… [we] started off with something small, which is easy to invest in, to something much larger with a more formal business case*" (I14)

"*… its evolved, so we've had to have various business cases along the way*" (I12)

During the investment process however, there are several stakeholders that will be involved, and it is important to understand the role that they play.

5.6.2 Stakeholders

Typically, when an IT initiative is proposed, stakeholders from the business area(s) that is being affected, and those who are directly involved in the project will be involved. While a proposal is normally triggered by a business problem or opportunity, IT departments were found to contribute to a large portion of the innovation.

"*… whoever's going to benefit from it. In [our] case, it [was] in the space of operations; so in this case, your Chief Operating Officer (COO) is your main component behind it, going through to your CEO*" (I49)

"… *we continuously try to innovate, it's one of the biggest things we try to do internally in IT*" (I85)

"*… a combination of ideas from the business … and also the technology team; the software development team*" (I8)

Furthermore, directors such as the CEO, CFO, CIO, and COO, are typically present for an IT proposal. During this stage of the project, there must be input from both business and IT parties. IT people may include development teams, business analysts, system owners, and process owners (I28). It is important to foster an environment in which multiple stakeholder input is encouraged because one needs to ensure that there are people that understand the business and how technology can support the business's needs.

It was also reported that although this mix is deemed necessary, there are often communication difficulties between the two parties (IT and business). Although this is not a particularly new phenomenon, organizations need to address this gap. Generally, there are differences in understanding, objectives, culture, as well as incentives between the two parties (Luftman, 2003).

"… *a lot of IT departments where the IT individuals are not business-oriented at all, they are very technical; they struggle to put forward a strategy and they don't understand the business well enough*" (I64)

"… *they [IT] also wanted to understand the ROI [but] they didn't understand the numbers in context*" (I33)

"… *there's always that gap of understanding*" (I65)

Some organizations were found to have established investment committees dedicated to reviewing and approving investment proposals. Directors from various departments such as finance, and in this case IT, will sit on the committee.

"… *we have what we call an IS investment committee that your CIO, the financial director, and one or two other directors sit on*" (I70)

"… *the actual investment decision that's being made at a senior level in the organization, what we call our Strategy and Risk Committee, so that's the executive committee*" (I11)

Multiple stakeholders input is also particularly important when it comes to the decision to build or buy, and especially in justifying the technology. This decision does not only involve IT, but requires a strategic and financial assessment as well.

5.6.3 Build versus Buy

The decision to build or buy the solution, as discussed in Organizational Considerations, may require the assessment of several factors. This decision is dependent on the organization's circumstances. It may require financial analysis to establish whether building a system internally, or buying it, is more financially prudent. At Co3, the decision to buy was based on a lack of time, budget, and development skills. More so, software development is not their core business.

> "*… we could sit and work one out ourselves and I could get a team of developers who could build one, but we'd have to weigh that up against maturing a product internally when we're retailers; we're not exactly software vendors*" (I80)

Findings show that organizations whose core competency is not software development, which is most, may not find it financially justifiable to build and mature a product internally. Co1, who on the other hand specialize in software development, realized that not only did they have the skills to develop in-house, but they could then offer it as a solution to their clients. For Co1, this was an excellent way to justify the investment from a ROI perspective (this will be explored further later in this chapter).

> "*… we [could] turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients*" (I18)

Organizations with experience in buying from vendors, reported a number of considerations that should be kept in mind. It was found that vendors are sometimes unable to satisfy all of a business' needs. Thus, it is advisable that organizations thoroughly review potential vendors for their offerings, their support, as well as their maturity.

> "*… there are situations when there is nothing on the market, I mean [for] real-time POS, there's nothing really on the market that allows us to do it in the fashion we wanted to do it in*" (I82)

> "*… [some] say they have got everything, but they don't*" (I84)

> "*... the thing is there aren't really vendors out there that have got to that level of sophistication*" (I81)

Furthermore, there are instances where organizations are forced to configure their own solutions by piecing different components together to create customized solutions.

> *"... plugging them together and coming up with a solution"* (I83)

Nevertheless, whether developing in-house or buying a solution, both can be a financial burden and will therefore need to be justified. Those who consistently delivered value from their investments reported that business is more likely to be trusting of their investment proposals.

5.6.4 Trust

Because business may not necessarily understand required investments in technical components, they need to be trusting of IT expenditure. It is common for an IT project to require a change in architecture, especially for enabling real-time BI; justifying these components however, is not an easy task. For instance, a message-bus, in isolation, does not demonstrate financial value. In the grand scheme of a real-time BI architecture however, it plays a fundamental role. Business therefore, needs to be trusting of IT decisions, especially when they are technical in nature and may not necessarily be understood.

> "*… like architecture, it's quite difficult to put forward and say what ROI [will be] on ESB*" (I79)

On the other hand, IT needs to earn trust from the business by consistently demonstrating value from its investments. This will also help business to be more trusting of future IT proposals.

At Co2, the IT forensic team's proposal for the investment was accepted relatively easily because they had, time and again, delivered value from their projects. The investment committee was therefore more trusting and willing to take on their proposal to implement the proposed system.

> "*…[we've] really shown a lot of value to the business, from what we take and what we give*" (I26)

One way in which they can gain trust is by being conservative in their ROI projections. The reason for this is to minimize the risk of failing to reach those targets, as this could also be detrimental to building trust.

> "*… [if you are] conservative about the impact of IT, they become more trusting on your submissions of expenditure when you have your ROI calculation*" (I61)

While trust plays a role in investment approval, it ultimately rests on whether the proposed benefits, financial or non-financial, can yield enough leverage to justify the cost.

5.6.5 Quantifying Benefits

Identifying measurable benefits of the proposed system is one of the most crucial components for building a credible business case for the investment. This is because the benefits, those that are measurable, are quantified and used to calculate a ROI estimate. This is said to play a key role in deciding whether an investment is approved, because it must first demonstrate that it is financially prudent. As previously mentioned, there are two forms of benefits, tangible and intangible.

5.6.5.1 Tangible Benefits

Tangible benefits are those that can be measured in context of the business problem they are solving, or the opportunity they are harnessing. For example, Co3 calculated how much in sales they were forgoing when an item was not in stock. This is something that financial value can be attached to and is thus used to illustrate how the investment will pay itself off.

> "*I took the Point of Sales (POS), so the most value in terms of a retailer, is that if you can see what's happening at the POS in sort of split seconds, then you know what's happening*" (I44)

Furthermore, with the ability to monitor sales in real-time, Co3 could monitor for stock-out or shelf-gap situations. They can do this by monitoring a product's average sales rate against its current sales rate so that if a drastic deviation occurs (within the limits of a threshold), an assumption can be made that the item is out of stock or depleted from the shelves. For Co3, this means that the situation can be alleviated much faster, thus minimizing the potential loss in sales. These are measurable business benefits, and by using them, Co3 were able to calculate what kinds of savings they would make by implementing the proposed real-time POS solution. This typically forms the ROI.

> "*… so obviously we had to bring forward the shelf-gap monitoring as quick as possible*" (I55)

As further support for the proposal, Co3 understood the indirect losses of not having products in stock.

> "*… in a retailer's world, you need to understand things like the halo effect of not having one item*" (I45)

"… *so the halo effect, you might say, not having [a] 2litre Coke, for R8.50, for 2 hours lost us this amount of money, but you didn't, you lost a hell of a lot of other business as well as a frustrated customer*" (I47)

What this means is that there can be a (negative) halo effect of not having one item because it can translate into much wider losses. For example, if a customer plans to buy several ingredients to make up a meal, but is not able to get one of the items, then the retailer may potentially lose sales of all the other items that would have otherwise been bought. In addition, Co3 also realized the value that real-time BI could offer by making stock replenishment more efficient.

"… they can receive their stock within a 24 hour period instead of a 48 hour period and keep the in-stock situation higher; so the bottom-line is that we would be that much more profitable" (I46)

At Co1, benefits could be derived from the financial impact and loss in productivity caused employee attrition. Part of the business case for Co1 was therefore around the quantification of talent retention.

"… *[the] business case is not that difficult because if we can [increase] our retention rate, that can be translated directly into the cost to re-hire someone; and there's metrics on that*" (I2)

In addition, Co1 planned to leverage their system into a source of revenue by offering it to their clients as a solution. This in turn will help to support the investment.

"… *we turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients*" (I17)

5.6.5.2 Financial Measures

After the business benefits have been identified and quantified, they will be used for calculating the investment's ROI. In addition, some organizations also applied hurdle rates in their calculations (I21). By definition, hurdle rates are the minimum acceptable rate of return that an organization will accept before approving an investment (Liesch & Knight, 1999, p. 387). Emphasis was also placed on taking the cost of capital and risk into account when calculating the ROI (I22). For instance, because Co1 was developing in-house, they needed to assess these figures because they would be using their own resources (employees) for the development of the system.

"*... because we were using our own skills to develop the system, [we had to look at] the cost of those skills in developing the system versus working on a client project and earning revenue*" (I22)

It is important to re-iterate the need to be conservative with ROI projections at this point of the proposal. As previously mentioned, failing to achieve these projections could compromise trust in current and future proposals.

"*… we're always very conservative on our ROI*" (I59)

"*[have to be] conservative about the impact of IT, [then] they become more trusting on your submissions of expenditure when you have your ROI calculation*" (I60)

Interestingly, at Co5, projections were deferred until value could be measured down the line. Thus, ROI projections may not always be necessary prior to the investment.

"*… we're too early at this stage to give a tangible measure of the return, we'll probably do that in the next 2 years as we start measuring the impact. We're just too young as an organization to give an accurate measure of that*" (I78)

5.6.5.3 Intangible Benefits

Real-time BI systems also provide many intangible benefits; these however are difficult to measure because they are non-monetary in nature. For this reason, some organizations follow a balanced scorecard approach which extends benefits realization to more than only financial dimensions (Kaplan & Norton, 2008).

For Co1, aspects such as staff motivation, staff engagement, and business knowledge made up some of the intangible benefits of their system (I19, I20). For example, the new system would help them in conducting performance management. Through the recognition and acknowledgment of good performance, employee incentive is likely to increase. As this is linked to job satisfaction, it is therefore likely to subsequently increase staff retention.

"*… when it comes to a service industry, professional services, what really makes a difference is when people are putting their discretionary effort into the organization*" (I4)

For Co2, the new system would bring information into the organization that was previously not visible. With this information they hope to better understand what syndicates may be doing inside the organization.

"… *the biggest win for us is more the new information that is coming to the force*" (I38)

These kinds of benefits are difficult to measure. While there are many intangible benefits that are brought about by real-time BI systems, there is a general uncertainty on how these should be used in a business case. Some organizations reported to have measured them whilst others would only list them.

"… *you obviously list all of your intangible benefits, but no one is going to sit there and try measure those*" (I62)

"… *we don't try measure any intangible benefits, we would [just] state them*" (I57)

Some organizations did attempt quantify these softer benefits by using estimations. For instance, Co2 calculated their softer benefits based on "*assumptions and history*" (I42). Although difficult to quantify in monetary value, it is important to understand that intangible benefits can indirectly contribute to ROI.

In summary, it has been emphasized that benefits form a key role in the financial justification of an investment. As a starting point, it is crucial that these benefits are identified and quantified (where possible). In doing so, the proposal must support its claims by illustrating the value that can be added by introducing real-time BI. Here, it is important to have a key understanding of the business areas being affected. In demonstrating value, there needs to be a positive ROI that is based on quantified benefits. While this is common practice, IT projects also offer many intangible benefits that are not as easy to quantify financially because they are non-monetary in nature. While some attempt to quantify them, others just state them; regardless however, they are still value adding factors that should not be overlooked. By including intangible benefits into the business case, whether quantified or not, stakeholders can use them to better understand the full value of the investment.

5.6.6 System Growth Planning

Some organizations were found not to have implemented their real-time BI systems from nothing. Instead there have been gradual developments of their existing BI systems. This approach reinforces the need to implement technologies that are capable of scalability, flexibility, and configuration.

For example, Co4 reported to have been on their existing architecture for many years, and that through iterative configuration, they have been able to support the businesses requirements for many years.

> "*We've … been in a very stable environment, in terms of a core environment (core transactional processing), for at least 18 years. We've been in this current data warehouse for 10 years now*" (I69)

In light of this, it is advisable that the choice in technology and environment should allow for configuration and growth so as to adapt concurrently with the changing business needs. This certainly reinforces the observation that the choice in technology should be scalable, flexible and able to accommodate for change.

> *"…we've had it going since 2007 and it's constantly evolving*" (I7)

From an investment point of view, this can be seen as increasing the amount of an already existing investment simply by supplementing or configuring the technology. Organizations who followed this approach normally adopted multiple business cases. Another advantage of this is that it makes it easier to manage growth. But more so, by continuously demonstrating value through these iterations, business is more likely to be supportive and trusting of the proposals.

> *"… [it] started off with something small, which is easy to invest in, to something much larger with a more formal business case*" (I15)

> "*… it's evolved so we've had to have various business cases along the way*" (I13)

Interestingly, Co4's technology was "real-time ready", meaning that no investment was actually required. It only required a configuration to the technology.

> "*… when [we] moved from where we were to real-time / near real-time, there was no investment required*" (I73)

> "*… we had foreseen … that we would go real-time at some stage*" (I74)

All in all, organizations need to be forward-facing in their IT investments so as to accommodate for system growth. Not only is it easier to demonstrate value, but also it is controlled and allows the system to adapt as the business grows and requirements change, similar to a maturity model. This encourages longevity of a system and/or architecture, thus attaining the most value from an investment.

5.7 Summary

This chapter has presented a detailed analysis of the findings that emerged from the interviews. The main areas reported included an analysis of Technological Considerations, Organizational Considerations, Application Areas & Analytics, Users, Benefits, and the Investment Process. By having analyzed each of the six categories, the next chapter will discuss the results further in relation to the literature and research questions.

Chapter 6 - Discussion

6.1 Introduction

A number of findings have been derived in this research, which have practical importance for real-time BI implementation. This section seeks to summarize and discuss these findings in relation to the proposed objectives of the study, and the four research questions (re-stated below). As such, the first section explains possible challenges and considerations of real-time BI implementation, both from a technological and business perspective. Secondly, the application areas and related analytics are reviewed, including how they are enabled in this environment. The third section addresses the planning and approval of a real-time BI investment, in which various benefits are discussed and the role they play in justifying the business case. Real-time BI is then assessed in terms of how it affects the users, particularly at how decision-making is influenced at different organizational levels, as well as issues surrounding training, resistance, and adoption. Finally the discussion chapter condenses the findings into a conceptual model that can assist practitioners in producing a meaningful and insightful justification for real-time BI.

1. What are the challenges and considerations, both technological and organizational, which need to be addressed when planning for, or moving into real-time Business Intelligence?
2. What are the application areas and related analytics of real-time BI, and how are they enabled in this environment?
3. What goes into the planning and approval of a real-time business intelligence investment and how is it justified?
4. How does the introduction of real-time business intelligence affect its users, and how does it influence decision-making at different levels of the organization?

6.2 Discussion of the challenges and considerations

6.2.1 Technological

The various technological and organizational challenges that were faced by the participant organizations, whilst implementing real-time BI, are outlined in Table 5 and 6. It is important for those wanting to implement real-time BI to understand these because they can compromise the success of a project. Agrawal (2009) states that one of the core inhibiting factors surrounding real-time BI implementation is due to the lack of clarity about the underlying technical components.

	Theme	Issue(s)
Technological Considerations	**Integration**	Multiple systems
		Distributed systems
		Difficult to change infrastructure
		Integrate without impact
		Legacy systems integration
		Migration
		Data consolidation
	Message-bus	
	Data	Structured & unstructured
		ETL Process
		Master data
		Historic data
		Data latency
		Data management
	Architecture	New tools & technologies
	Flexibility	

Table 5 - Summary of the Technological Considerations

The findings suggested that a common problem in organizations is that business systems and data structures are often not integrated, and tend to be distributed across various areas. This supports Sahay and Ranjan's (2008) claims that systems need to be integrated, often from multiple platforms and locations. Further, organizations that have different platforms may be required to migrate their data; this process is likely to require separate ETL processes to ensure data format compatibility. This leaves IT departments with a large workload when it comes to integration. For a real-time BI system to add value, all departments and business systems need to integrate and consolidate into a single repository (DW), so as to offer enterprise-wide analysis (Rajterič, 2010). In order to do this, many organizations advocate the implementation of a communications channel, or message bus, through which all the systems integrate, talk, and connect to the DW. It is also important to ensure that the integration process does not affect the workings of any operational systems, as this would interrupt business processes.

Organizations also need to decide what data they want to monitor. Typically, this is structured data, such as transaction data, which is already in a form that can be quantified and analyzed relatively easily. Analytics can also extend to less structured data, such as qualitative data, as was seen at Co1. These two types of data however require different ETL processes, and are monitored using different techniques. Furthermore, the maintenance of historic data and master data is stressed throughout the research as it plays a key part in providing real-time information along with its entire context (Hackathorn, 2002).

After the data is sent to the message-bus from the host systems, it will undergo ETL processes before it is all consolidated in the DW. In a real-time BI environment however, analytics can be applied to the data before it gets to the DW. This typically takes place between the source systems and the DW. For instance, the ODS can monitor real-time data by intercepting it as it flows through the message-bus. In an ODS environment, analytics can be applied to real-time data. In order to do this however, the ODS needs to keep historic records of data, which are derived from the DW, and are used to put real-time data into context. In doing so, organizations need to understand the latency of data, from when it is created to when it is ready for analysis, and define what real-time means to them.

In light of this, there are many technical challenges to enabling such an environment, which in a large organization, can be even more difficult to overcome. A large organization is not only likely to have more systems that need to be integrated, but because business processes are in flux, the system needs to accommodate for this. For example, where products change and departments re-organize, business processes will change too. Real-time BI solutions therefore need to be flexible so that they can adapt to these kinds of changes without requiring major configurations to the systems. Flexible and scalable BI environments are also important as they make it easier to mature and evolve a BI system. Co4 is testament to this, as they did not require major investments to implement their real-time BI; instead, they configured their former BI and were able to enable real-time.

Implementing this architecture therefore, requires a good understanding of the many technical components that fit together to enable a real-time BI environment. By understanding these components and concepts better, perhaps organizations may be less reluctant to implement such systems due to a lack of technical understanding.

6.2.2 Organizational

Organizational Considerations	Theme	Issue(s)
	Requirements	Need to be defined
		Incorporated into business case
	Cost	Technological
		Organizational
	BI / DW Maturity	Maturity assessment
		Phased development
		Data
	Business Rules	Need to be defined
		Monitoring data
		Golden standard of information
	Bus. Process Re-engineering	Enterprise-wide
		Planned change
	IT Skills & Support	New tools & technologies
		Management of skills
		Training
	Build versus Buy	Build : skills
		Build : justification
		Build : maturity
		Buy : configuration
		Buy : vendor assessment
	Change Management	BPR management
		User resistance

Table 6 - Summary of the Organizational Considerations

There are also several organizational considerations that surfaced in this research. Interestingly, most of these, and many of the technological considerations, are areas that correlate to phases of BI maturity. BI maturity models suggest that organizations should go through the phases of maturity in an iterative manner (Rajterič, 2010). By assessing where an organization is in terms of its BI maturity level, it can better understand what still needs to be implemented in order to move into more sophisticated realms of BI, such as real-time BI.

Furthermore, findings show that most organizations did not implement real-time BI from the start, but instead iteratively and gradually evolved into real-time BI from their previous BI investments. This corresponds to the concept of BI Maturity development, which states that each phase has key areas that need to be achieved before further levels of maturity can be reached (Rajterič, 2010). This point re-iterates the need to deploy solutions that are flexible, and that can grow and adapt to changing business needs.

Eckerson's (2009) TDWI model was found to reflect many of the findings that have been raised in this research. For instance, a less mature BI is likely to be non-integrated with scattered data sources, and often no common standard of metrics and rules between them. In this phase, not only is there no view across the entire organization, but there are different versions of the truth; this was akin to Co5's situation. It is for this reason that organizations need to have defined business rules before they can begin to monitor data; they ensure that a single standard of information exists. In addition, active decision engines require business rules in order to be capable of recommending or taking actions when exceptions or situations are discovered (Nguyen *et al.,* 2005). In contrast, a more mature environment has integrated data sources that are consolidated into a single DW. When maturity is in the *adult* phase, this integration is then in real-time. There is an enterprise-wide view of information, information can be turned into action, and common standards in place, which for decision-makers, is of the utmost importance. Decision-making is also enhanced through the implementation of dashboards and KPIs; these can monitor the current state of the business in real-time.

These findings also support Watson *et al.* (2006) who suggest that, because real-time BI requires technical solutions, good business cases, as well as process change, a more phased approach should be applied for its implementation. As such, it is advised that organizations should first conduct a BI maturity assessment in order to understand at what level they are in terms of technology, skills, and standards.

In the preliminary stages, organizations also need to assess whether they are going to build or buy the technology required for real-time BI. This is a decision based on several factors. If the decision is to buy, Bugajski (2010, p. 4) stresses that there needs to be a "good match between a BI platform's capabilities and a business's information requirements". Findings however, show that sometimes there are no adequate solutions on the market and that organizations are forced to purchase different components, configure them, and come up with the a custom solution.

The consensus, from organizations that are not in the software development industry, is that it is a lot cheaper to buy solutions than it is to build them. This is because of the resources that go into building an entire solution, such as human resources and time spent on maturing a product internally. There are however benefits of building a solution in-house. Not only are they better tailored, but also for software developers, the solutions can be turned into a source of revenue. At Co1, the system is offered as a solution to clients. This in turn helps to justify the investment itself.

It is evident that implementing a solution is not always clear-cut; it may be a case of buying, buying and configuring, or building. If the decision is to buy, organizations are encouraged to assess vendors thoroughly, namely in terms of maturity and support. Regardless of the decision however, an organization must have the IT skills in place to implement and provide ongoing support for the solution. With the introduction of new tools and technologies that enable the real-time BI environment, IT staff may require training. Organizations also need to manage these various skill sets. For a large organization, Co3 found it difficult to bring these skill sets together and manage them as a unit. This however, could also be difficult for smaller organizations that do not have as many people they can afford to commit to a project.

With a real-time BI environment, many business processes are likely to require re-engineering. In an environment where business processes can drive themselves and respond automatically to situations, Kilcourse and Rosenblum (2008) advise that, to close the loop between transactional systems and analytics, organizations need to move towards an engineered approach to their processes. To do this however, requires skilled persons who not only understand the business, but who are also IT minded. These skill sets need to be brought together, managed, and made available to the organization not only during implementation, but for ongoing support afterwards.

Because process re-engineering is enterprise-wide, organizations are advised to apply change management practices to facilitate this process by managing the relationships between management, technology, organizational structure, and people (Kettinger & Grover, 1995). Furthermore, change management strategies help to manage user resistance so that it does not compromise the success of the project.

In light of the findings thus far, it is evident that cost will play a major role in an organization's willingness to adopt real-time BI. This supports Agrawal's (2009) claims that cost is one of the main reasons why organizations are reluctant to implement such solutions. On the technological side, acquiring new tools and technologies, coupled with the development of skills, will have a big impact on the budget. In addition, consulting, training, and support are also likely to contribute to the expense. It is for this reason that the business case must adequately address these costs in terms of how they will be paid off through the realization of benefits. This is crucial because the investment will not be approved unless it can demonstrate where the real-time BI system will offer value (Lönnqvist & Pirttimäki, 2006).

It is for this reason that, when putting together the business proposal, it is crucial to have defined business requirement(s) for the real-time system. This is typically what triggers the proposal and is the driving force behind the investment. For instance, Co3 realized the importance of reacting faster to stock out situations, and could therefore justify the need to put real-time on their POS systems. In other words, these are the area(s) that real-time BI can offer quantifiable value to. In addition, it is essential to calculate the project's ROI; this is discussed in the investment section in more detail. Although this tends to be difficult with IT, especially with BI (Soh & Markus, 1995), a maturity model can help to demonstrate the kinds of benefits that can be achieved by moving into a more mature real-time BI space.

6.3 Discussion of the Applications and Analytics of Real-time BI

A summary of the application areas and related analytics of real-time BI are presented in Table 7.

	Application Area	Analytics
Real-time BI Application	Process intelligence	Analysis and visibility
		Business activity monitoring
		Situation and anomaly detection
		Prediction
		Business process improvement
		Automation
	Fraud detection	
	Supply chain optimization	
	Dynamic pricing & yield management	
	Customer relationship management	
	Demand monitoring & forecasting	

Table 7 - Summary of Application Areas and Related Analytics

6.3.1 Process Intelligence as an Enabler

It is evident that process intelligence plays a fundamental role in the entirety of a real-time BI system by providing visibility, control, and improvement at the process level, and enabling a host of different analytics. This supports the claims made by Ioana (2008) who states that process intelligence can use data, as it is created in operational systems, to facilitate decision-making, as well as to drive and optimize business operations. These aspects are categorized into five distinct groups: analysis, prediction, monitoring, control, and optimization (Grigori *et al*., 2004, p. 322).

Business process intelligence allows users to *analyse* business processes, operations, and activity executions. Typically, IT people will look at low-level information, such as process logs, and business people at a higher level, such as the total number of business process failures and their impact on performance. In addition, users can dig through this data to understand, for instance, where a business process went wrong; this subsequently leads to minimized impact of bad situations, and over time, process improvement. Similarly, *prediction* techniques can assist in identifying the possibility of exceptions, undesired behaviour or estimated future outcomes occurring.

Systems can then *monitor* these live processes, against metrics like KPIs, and alert the user when there is undesired or abnormal behaviour. With this, organizations can view the status of systems, processes, services, and targets in real-time. Many organizations deploy BAM software because of its ability to monitor data against custom KPIs and its alerting capabilities. While BAM will alert a user when there is need to make a decision, there are configurations that can *control* and drive operations automatically which are based on business rules. This is highly advantageous for routine decisions as well as time-sensitive issues, such as minimizing the impact of a negative situation.

Furthermore, Raden (2003, p. 8) states that real-time BI analytics can offer significant value to situations "where the organization's response to a set of variables can be well defined, automatic, and reflexive", for example, in dynamic pricing. Real-time BI application is also appropriate for areas that require time-sensitive decisions. Time sensitive decisions are typically characterized where there is high risk or high cost, where there are numerous and often-conflicting constraints, where there is potential for decision optimization using context (historic) data, where early identification of anomalies or opportunities can provide strategic advantage, and where decisions are made frequently, but can collectively offer value through optimal execution (Raden, 2003). As many of these decisions are common in operational levels of the organization, process intelligence therefore plays a key role in optimizing the decision-making process.

6.3.2 Application Areas

In light of the above-mentioned findings, it is easy to see how they may be applicable to various types of real-time BI analytics. Because these core principles are present amongst the different types of analytics discussed in this research, they have significant practical importance for real-time BI implementation.

Fraud detection, for instance, offers an excellent example of an analytical process that follows these core principles. In short, fraud detection works by monitoring transactions and user activity through complex rules engines that look for irregularities in data or situations that correspond to possible fraud risk scenarios. Rules engines have a series of fraudulent behavior indicators, which when breached at a certain threshold, will flag a transaction as suspicious. By alerting forensic examiners to these situations early enough, the likelihood is that they can be prevented.

Therefore, to configure such a system, organizations must first analyze records of data in order to learn and uncover indicators of fraudulent behavior. An example of a fraud risk scenario is if there is a change in a physical address followed by a withdrawal of money (A24), as indicated by Co2. These are signs of suspicious behavior that can be discovered by digging through typical fraud scenarios, and which then become part of the rules engine. Data mining techniques can also be used to derive trends, such as average spending patterns, which are then used as an indicator of what normal behavior should be. Consequently, when live data is monitored through these rules, alerts can be raised when there is a breach in these thresholds. As such, it is easy to see how the fundamentals of process intelligence play a pivotal role in the entirety of this process.

Nevertheless, organizations were found to initially implement real-time BI in one area and then later discover new valuable areas for application. As Co3 state, it is an ever-learning environment. However, other real-time BI analytics that surfaced in this research include supply chain optimization, dynamic pricing and yield management, demand monitoring and forecasting, and customer relationship management; all of which utilize the same principles discussed above. For example, the key elements of CRM involve getting the right information out as fast as possible, making decisions quickly, and monitoring the current state of the business. These requirements are all supported in this kind of environment. It is for this reason that if organizations can understand these concepts, then they can apply real-time BI wherever they see fit. Furthermore, ongoing application of these techniques will help to iteratively improve processes towards a more optimized and efficient state, as well as provide extra opportunities to increase profitability.

6.4 Discussion of the Benefits and Investment Process

In light of the discussion thus far, it is evident that most organizations tend to grow into real-time BI as they move through the stages of BI maturity. Its implementation however is coupled with potentially high costs, but also potentially high rewards. For this reason, the justification of the investment needs to attract and persuade investment decision makers. While there is considerable literature surrounding IT investment justification, there is still no best practice for doing so, and BI is a particularly difficult technology due to the nature of its benefits (Kilcourse & Rosenblum, 2008). It is not uncommon for an IT initiative's value, especially real-time BI, to become embedded in a business process where, unless the evaluation technique can measure the system accurately, "managers may only see the resulting system maintenance costs and no real added business value" (Gibson *et al*., 2004, p. 297). Furthermore, the quantification of intangible benefits is a relatively grey area surrounded by varying opinions as to their role and extent in the business case. It is also apparent that real-time BI implementation is associated with high costs, and this is one of the main reasons why organizations are reluctant to adopt it (Agrawal, 2009).

For an investment, the assessment of value is based on two factors, the cost of the investment and the benefits of its application (Lönnqvist & Pirttimäki, 2006, p. 354). While cost is relatively easy to assess, the benefits of IT, especially BI in general, are much more difficult. The business case suggested by Ward *et al.* (2008) however, was found to offer a structured approach for doing so and will therefore be used as the basis for real-time BI justification.

This section will discuss the planning and approval of a real-time BI investment, and the role that business benefits play in the business case. Co1 and Co2 will be used as examples to illustrate this process.

6.4.1 Requirements / Driving Force of the Investment

Findings suggest that, as a starting point for the investment, it is important to isolate a financially justifiable business problem(s) that can be alleviated with the introduction of real-time BI (Hackathorn, 2002). This is the business driver of the investment. In other words, organizations must first identify the issue(s) that they are facing, as this will give leverage to the rest of the business case. In addition, it serves to put the proposal in context and to describe the bigger picture in a language that business can understand.

Co1: The driving force for Co1 was centred around the high employee attrition rate, and secondly, the difficulty of finding and retaining talent. As a services provider, people are the most important asset for Co1.

Co2: The driving force for Co2 was around the high rate and cost of fraud, and more so, the inability to find it in time. Instead, it was only discovered during audits (after-the-fact), when the transaction(s) had already been processed. It was also often found that fraud was correlated to insider jobs where syndicates would work together to facilitate malicious transactions. Furthermore, as further leverage, Co2 utilized a projection by the ACFE (American Certified Forensic Examiner Association) which estimates 5% of an organization's turnover to be the amount of fraud.

6.4.2 Investment Objectives

After having identified the high level drivers, it is important to state what the proposed investment seeks to achieve for the organization (Ward *et al.,* 2008). These are the objectives of the proposal which state how those drivers will be achieved.

Co1: To decrease employee attrition rates through better management of employee performance, career and growth development, and general work satisfaction. By understanding what the indicators of employee attrition are (likelihood to leave) and being able to monitor their signals in real-time, Co1 can address those situations proactively, before they come into being.

Co2: To decrease the amount of fraud by monitoring user transactions for suspicious behaviour and proactively alerting forensics when signs of fraud are found. With an early warning, fraud is more likely to be stopped before it can materialize.

6.4.3 Investment Benefits

Following the objectives, the identification of the expected business benefits is probably one of the most important components of the business case; these are the "advantages provided to specific groups or individuals as a result of meeting the overall objectives" (Ward *et al.*, 2008, p. 6). Furthermore, they need to be classified and quantified wherever possible (as shown in Table 8 and 9). This is critical because quantified benefits are used to derive the ROI, which in many ways is the deciding factor when assessing if an investment is prudent or not. In addition, the ROI figure must adequately address how the investment will pay itself off.

Some of the benefits for Co1 included:

Benefit	Degree of explicitness	Measure
Talent Retention	Financial	Current rate of attrition × cost of re-hiring and training a new employee
Reduced impact to project productivity caused by employee resignation	Observable	
Ability to proactively alert the organization when there are concerns of possible attrition	Measurable	Estimated rate of finding attrition indicators and their success rate in reducing attrition

Table 8 – Listing of benefits for Co1, following Ward *et al.* (2008) approach

> *"... the business case is not that difficult because if we can lower our retention rate, that can be translated directly into the cost to re-hire someone and there's metrics on that"* (I2)

Some of the benefits for Co2 included:

Benefit	Degree of explicitness	Measure
Savings in resources spent on fraud recovery procedures	Financial	Number of fraudulent transactions found in audit (which could have been prevented) × average cost of recovery procedure
Savings in fraud that could not be recovered	Financial	The total cost of fraud that could not be recovered
Change from addressing fraud after-the-fact (reactively) to before-the-fact (proactively)	Quantifiable	Number of fraudulent transactions that could have been prevented if the technology was in place
New information (the ability to track user behavior by monitoring transactions)	Observable	

Table 9 - Listing of benefits for Co2, following Ward *et al.* (2008) approach

"I looked at everything that was reported to forensics and from that I isolated the items that I believe a good enough technology could [have] picked up" (OC18)

"But the biggest win for us is more the new information that is coming to the fore so that we could look at what syndicates are doing" (I38)

In light of this, it is evident that there is often a mixed bag of business benefits. As such, it is crucial to categorize them based on the degree of explicitness and, where possible, outline how they can be measured (Ward *et al*., 2008). In demonstrating the value of the investment, there needs to be a positive ROI that is supported by quantified business benefits. While this is common practice, BI projects offer many intangible benefits that are not as easy to quantify financially because they are non-monetary in nature (Lönnqvist & Pirttimäki, 2006). Findings suggest that, regardless of their nature however, they should always be included in the business case. This is because "the limitations of financial appraisal techniques are well known and, given the many uncertainties of IT projects, even those organizations which apply them rigorously appreciate that basing decisions solely on estimated financial values will limit the types of business investments it makes" (Ward *et al.,* 2008, p. 12).

Organizations must also remember that they should try to be conservative about their ROI projections so as to minimize the risk of falling short of those targets. Failing to reach these targets can compromise the trust in current and future projects (I59; I60). This supports the findings of Ward *et al.* (2008, p. 10) who state that "over 50% of the less successful organizations admit to often overstating the benefits to gain funding".

6.4.4 Costs and Risks

The decision to build or buy the technology is one of the main cost factors that warrant financial analysis. This is because it is important to establish whether building a system internally, or buying it, is more financially prudent given the organization's circumstances. The consensus, from organizations that are not in the software development industry, is that it is a lot cheaper to buy solutions than it is to build them. This is because of the resources that go into building an entire solution, such as human resources and time spent on maturing a product internally. For example, Co1 had to include the cost of capital in their ROI calculation due to the labor and time that would be spent on development as opposed to working for clients and earning revenue. Co1 was able to justify these costs with the decision to offer the system as a solution to clients once it had been matured.

While there are many costs associated with real-time BI implementation, the majority are relatively easy to calculate. For instance, costs for hardware and software, implementation, systems development, upgrading infrastructure, consulting fees, training, etc. The costs associated with making business and organizational changes however, are less predictable (Ward *et al*., 2008). Organizations should also outline the cost of not implementing the proposed system in order to assess what kinds of losses they stand to make, given their current situation.

It is also important to outline the possible risks associated with the endeavor that could prevent the realization of all / some of the benefits. Some of the risks that surfaced in this research include user resistance, limited existing change management capability, the scale of the required business process re-engineering activity, confidence in the evidence of some of the benefits, confidence in some investment costs, and the complexity of the technology.

6.4.5 Investment Committee and Stakeholders

After completion of the business case, it will then be sent for review. Many organizations have investment committees dedicated to reviewing investment proposals, whereas some bring together the necessary stakeholders on an ad hoc basis. Typically when an IT initiative is proposed, stakeholders from the business area(s) being affected will be involved in the project; these are the people who are going to benefit from it. Furthermore, directors such as the CEO, CFO, CIO, and COO, are typically present for an IT proposal. In addition, it is important to have a mix of stakeholders from both IT and business; IT people may include system owners, process owners, and business analysts. Multiple stakeholder input is important because one needs to ensure that there are people that understand the business and and how technology can support the business's needs.

6.4.6 Summary of the Investment

Although a real-time BI investment may be associated with high costs and major business changes, there is sufficient evidence of the credible business benefits it can offer. For example, Table 10 shows the various benefits that emerged out of this research; all of which can assist organizations in cutting costs and risk, and subsequently increasing profits and opportunities (Watson *et al*., 2006).

	Theme	Outcome
Benefits	**Real-time Business Information**	Increase visibility
		Deliver actionable information
		Improved decision-making
		Decentralized decision-making
	Learning and Discovery	New information
	Prediction	Accurate forecasting
		What-if scenarios
	Proactive Responses	Proactive alerting
		Proactive decision-making
		Lower risk, Maximize opportunity
	Automation & Adaption	Information into action
		Anomaly detection & automated alerts
	Business Process Improvement	Adapt to changes in business environment
		Better use of resources

Table 10 - Summary of real-time BI Benefits

Nevertheless, the bottom line seeks to assess whether the proposed investment offers adequate quantifiable value to justify the costs of the project. While it is true that BI is difficult to justify, given the nature of its benefits, such as improved quality of information, better decision-making and business knowledge, real-time BI is somewhat different. This is because real-time BI is a specialized form of BI, with benefits that are generally more defined and less ambiguous. This also implies that it may not be beneficial to every organization however, because not all require low latency data (Hackathorn, 2002, p. 8).

For this reason, it is critical to first identify high-level drivers for real-time BI, and then break that down into objectives and benefits. This will help to formulate the justification for its investment through the demonstration of credible business benefits. In doing so, a business case not only assists with obtaining funding, but it shows the types of changes that are needed in realizing the business benefits, gaining commitment, as well as allowing the success of the investment to be judged objectively (Ward *et al*., 2008).

6.5 Discussion of the User in a Real-time BI Environment

To understand how the deployment of a real-time BI system affects its users, an assessment was conducted at strategic, tactical, and operational levels of the organization in order to understand data requirements, training requirements, resistance and adoption issues, and the impact on decision-making. These are outlined in Table 11.

	Theme	Outcome
Users	**Data Requirements**	Low latency + historic data (Operational)
		Historic data (Strategic and Tactical)
		Vary with types of users
		Context-specific dashboards
	Training	Operational users lack BI skills
	Resistance, Participation, and Adoption	Operational users not accustomed
		System design
		Change management
	Decision-making	▲ Operational users
		▼ Decision & Action latency
		Decentralized
		Proactive
		Optimized

Table 11 – Summary of user-related aspects

An assessment was first conducted to identify the differences in requirements at different organizational levels; in terms of objectives, types of users, and data latency requirements. At the strategic and tactical level, information requirements were found to be typical of traditional BI. For instance, the former focuses on reaching long-term objectives (strategic goals). Users, who are top management, want to analyze the organization's performance in areas that directly affect strategic objectives, and want to have global visibility of the business. The analysis is therefore done on data with a much higher temporal window, such as weeks or even months; this is mainly historic data. Similarly, at the tactical level, the focus is on reaching tactical objectives which are defined around the strategic goals and users typically include top management, financial analysts, and business managers. At this level however, the data latency is normally within weeks or days and also requires historic data.

In contrast, operational / real-time BI seeks to provide visibility into the current state of operations; therefore the required latency of data is much lower, often in terms of minutes or even seconds. For instance, in order for operational managers at Co3 to see current stock levels, they require low latency transaction data and contextual historic data. Due to the nature of operational BI, users want to manage and optimize daily operations. In doing so, real-time BI allows them to create KPIs and then actively track them against strategic objectives. This verifies Ranjan's (2008, p. 468) statement that organizations must understand how current business activities affect strategic and tactical objectives by "establishing the status of [the] business at any moment in time in relation to its performance objectives".

Furthermore, requirements vary not only across organizational levels, but across different types of users. In other words, those who require access to real-time data may have specific requirements, which must be first understood and then made available. For example, forensic analysts at Co2 need access to specific data during fraud investigation; namely the payment transaction, the respective policy, the policy owner, geographic data, inception data, etc. (U14; U15). Furthermore, Grigori *et al.* (2004) explain how IT and business will typically look at different elements of business process data. IT wants to see low-level information, such as the details around process logs, while business will look at higher level information, such as the total number of process failures and their impact on performance. For this reason, it is important to assess the users of the system, prior to implementation, so as to understand how their data requirements vary.

In addition, information must then be delivered to its respective users. Advances in real-time BI dashboards aid in the dissemination of information to different user groups around the organization (Eckerson, 2006). Dashboards can exhibit data at three different levels; namely "graphical, abstracted data to monitor key performance metrics, summarized dimensional data to analyse the root cause of problems, and detailed operational data that identifies what actions to take to resolve a problem" (Eckerson, 2006, p. 6). In light of this, dashboards can be deployed at different organizational levels and can be configured to display different visibility, depending on the business context and requirements. For example, operational dashboards are used to monitor core operational processes and typically display more real-time data. Tactical dashboards are used to track departmental processes and projects, and strategic dashboards monitor the performance of strategic objectives.

Although there tends to be a form of segregation between strategic, tactical, and operational levels, it seems that real-time BI is providing better coordination and synthesis between them. This addresses an issue raised by Azvine *et al.* (2005), which states that the challenge is to apply technology that can automate the flow of information from operational to tactical to strategic layers, and translate strategic objectives into operational metrics. In other words, real-time BI plays an important role in aligning strategic objectives to operations and providing cross-organizational alignment between them.

The analysis also found that decision-making in a real-time environment is improved in many ways. Firstly, findings show that, due to the operational nature of real-time BI, there is an increase in the number of operational users and micro decision-making. The need for operational users to make faster decisions, spot emerging trends, and take immediate action when problems arise, as discussed by Ioana (2008), is therefore increasing in this environment. Furthermore, in an environment where enterprise-wide systems are integrated in real-time, users have better visibility on the current state of the business.

While traditional BI was used for historical analysis that was geared for reactive decisions, real-time BI can alert users prior to a problem occurring so that it can be addressed proactively. Through application of predictive analytics and anomaly detection techniques, problems can be addressed before they can be of detriment. For example, with the ability to sense fraud as it happens and alert users to it, Co2 could actually prevent it from taking place. Furthermore, when a situation such as this occurs, which requires user intervention, a real-time BI environment facilitates the allocation of that decision; this is decentralized decision-making.

With real-time BI however, decision-making is also becoming increasingly automated, especially at the operational level where common and repetitive decisions are frequent. As the need to make faster decisions grows, the ability to drive business processes is seen as a major advantage as it supports the transition from information into action. In other words, real-time BI is closing the loop between operational systems and BI in order to reduce action (response) and decision latency (Melchert *et al*., 2004). Decision-making is becoming increasingly embedded into the normal business workflow whereby systems are able to automatically sense conditions / identify problems. They can then make near optimal decisions and propagate actions based on the best knowledge available;

In light of this, the deployment of a real-time BI system will impact users in a variety of ways. This change however will need to be managed so as to avoid potential resistance to the system, and subsequently facilitate its adoption. It was found that one of the main causes of resistance was due to change, especially at the operational levels where users are generally not accustomed to using real-time information to make decisions. As this is a new way of thinking, the application of change management may be required. Similarly, because operational users are likely to lack the skills to use BI tools (Ioana, 2008), organizations need to ensure that they are adequately trained to do so, and that the BI tools are as user-friendly as possible. Similarly, at Co1, the system design incorporated typical features of social-networking because their users, are on average, already familiar with social-networking. This subsequently helped to increase the utilization of the system. For this reason, while implementing a sophisticated real-time BI system can offer users significant benefits, if they cannot use it, it may compromise the success of the entire endeavor.

6.6 Summary of Discussion

In light of the discussion, there are a number of findings that can be derived from this study, which may have practical importance for organizations wanting to implement real-time BI. The information that has been gathered, through answering the proposed research questions, has been used to derive a model that aims to assist organizations in producing meaningful and insightful justification for real-time BI.

The conceptual model in Figure 13 (Roadmap for real-time BI implementation planning) is the product of the information gathered from interviews and literature. While all the components of the model are supported by the findings of the study, it was constructed through the researcher's own suggestions and ideas. Furthermore, it is the opinion of the researcher that the proposed model provides sufficient theory to address the primary objective of the research, which was:

"… to produce a model or framework which serves as a guideline for organizations that are planning on moving into the real-time BI sphere. The purpose of the model would serve to inform and equip organizations with the necessary information they should know before pursuing such an investment".

6.6.1 Proposed Model

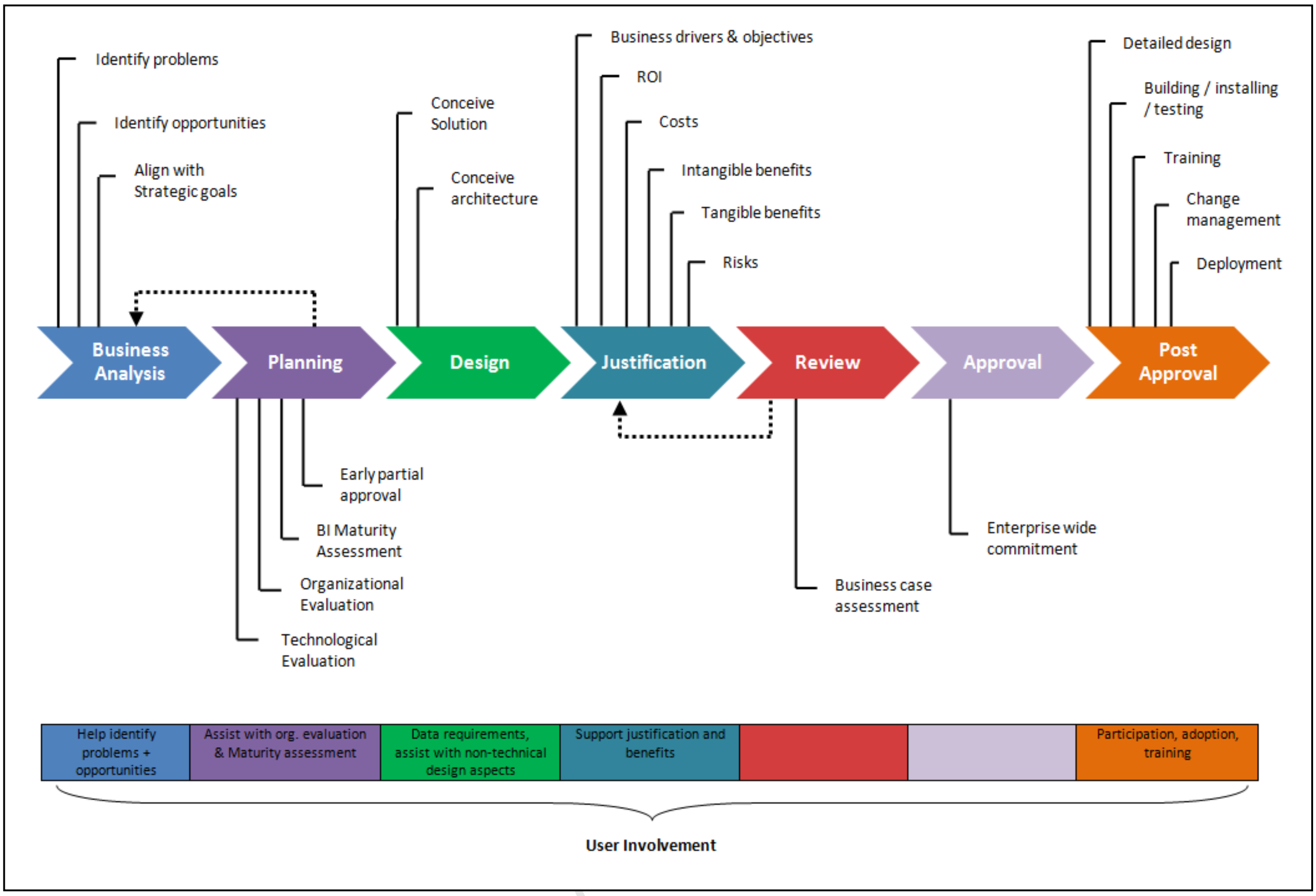

Figure 13 - Roadmap for real-time BI implementation planning

Business Analysis: The business analysis phase is the first and possibly the most important step in building a successful case for real-time BI. In essence, this is what will drive the investment proposal throughout the entirety of this process. As a starting point, it is vital to identify a business problem that can be overcome, or an opportunity that can be exploited, through the implementation of a real-time BI system. For example, the driving force for Co2 was the high rate and cost incurred from fraud, and more so, the inability to find it in time. This is something that financial value can be attached to, and is crucial in illustrating how the investment will pay itself off (during the justification stage). Similarly, organizations can also identify critical business units and/or processes that give rise to the need for real-time BI. User involvement can be a good source of information at this stage as they are likely to provide insight into problem areas or opportunities, as well relevant analytics and application areas.

Organizations must also realize that a good proposal should align itself to, or be supported by strategic business objectives. In other words, the problem that is being solved, or the opportunity being harnessed, must tie directly to a strategic business objective(s). This not only gives the proposal more credibility, but it is likely to increase incentive at an executive level.

Planning: After completion of the business analysis phase, organizations need to identify what changes will be required in moving forward with the proposal. In doing so, organizations need to assess their own readiness, from a technological and organizational perspective, to move into real-time BI. The research found BI maturity assessment frameworks to offer valuable assistance in doing this; for instance Eckerson's TDWI model (2009), or from the Gartner Group. This will help organizations to assess exactly how ready they are to move into a more sophisticated level of BI maturity, and also outline what needs to be done to achieve it.

It is likely that most organizations will already have many of the components in place, provided they have existing BI infrastructure. Emphasis however must be placed in evaluating the extent of integration and consolidation of business systems, how ETL processes will be configured, the deployment of a message-bus or communications channel, and the data latency requirements. These are key components in enabling a real-time BI infrastructure and adequate attention should therefore be given to them.

Organizations should also assess what organizational considerations they may need to address in proceeding with the endeavor. Common requirements at this level include user training, business process re-engineering, evaluating the current level of IT skills and support, defining business rules and data standards, data management, as well as change management practices. It is important to note that many of these requirements can be addressed in more detail during the Post Approval stage, but it is encouraged that they are recognized in this phase. Furthermore, user involvement at this stage can assist with the evaluation of requirements and assessment of maturity.

A proposal may require partial approval at this phase; for this reason, it is important that the business analysis has been conducted in detail, the status quo has been evaluated, and the requirements for achieving the desired real-time environment have been understood. This is because at this stage of the process, a preliminary budget may be required, and both IT and business users will be needed to take the proposal forward. Business users may include BI “power users”, a champion, sponsors, and senior executives. If organizations are able to succeed in obtaining partial approval, it is likely to add leverage to the business case down the line. For this reason, if there are concerns regarding the proposal at this phase, organizations may need to return to the Business Analysis phase (illustrated by the dotted line in Figure 13).

Design: The Design phase is primarily centered on conceiving a solution for the identified business problem / opportunity, and also a solution for the required architecture. For the former, a build or buy analysis may need to be conducted in deciding how the solution will be delivered. Research found that careful attention should be paid in evaluating vendor offerings in terms of maturity, delivery, available skills, and ongoing support. If the solution is being developed in house however, further financial analysis, such as cost-benefit analysis, should be carried out, as well as an assessment regarding the existing level of internal IT skills and support. Market analysis during this phase may also help to discover what kinds of technology and analytical environments are available. Nevertheless, the desired solution should clearly demonstrate how the goals, identified in the first phase, will be achieved. In doing so, it is often a good idea to first conceive a solution for a specific business area. For example, by implementing real-time to one area, at the POS, Co3 were able to deliver results quickly and gain commitment from the organization. By doing so, they gained enough traction to then expand real-time BI to other areas of the organization. This is a commonly applied strategy, whereby organizations first aim for the easiest and quickest wins, or the “low hanging fruit”, which can yield results relatively quickly, thereby assisting both current and future support. It may also be useful to adopt principles of prototyping during this stage whereby the proposed solution is demonstrated as a tangible concept. This can be particularly useful because business users may not necessarily understand the technical aspects behind the solution. Furthermore, users should be involved during this phase as they can assist with non-technical aspects of the design; and it serves as an opportunity to understand their respective data requirements.

The latter phase, conceiving the required architecture, is also important as it outlines what still needs to be done to enable the architecture which can support the solution. This will largely depend on the results of the maturity assessment during the planning phase. Research found that enabling the architecture is likely to require systems integration, a change in ETL processes, master data management environments, as well as possible deployment of components such as a message-bus and an ODS.

At this point, it may be useful for real-time BI practitioners to look at the various types of analytics and application areas that were discovered in this research. This can provide insight into areas of application that perhaps were not considered, and can also demonstrate the kinds of benefits that they yield.

Justification: It is at this stage of the process where organizations need to deliver a comprehensive business case that addresses the specifics of the proposed investment. This is a critical component in the process because it needs to demonstrate, with substantial evidence, what kinds of benefits the investment will yield, and how they will cover the costs required for putting the solution in place.

As already mentioned, the starting point is to isolate financially justifiable business problem(s) and / or opportunities that can be addressed with the implementation of real-time BI. This is the business driver of the investment. This should put the proposal in context by describing the bigger picture, paying attention to the driving force of the business case, as well as how it supports high-level strategic objectives. Having said that, it is critical for practitioners to understand that the justification should be business-driven and not IT-driven; this is because IT predominantly supports business functions, not the other way around. After having specified the driving force, the business case should make it clear what the proposed investment seeks to achieve for the organization; these are the objectives. Using Co2 as an ongoing example, the objectives were to decrease the amount of fraud by monitoring user transactions for suspicious behaviour and proactively alerting forensics when signs of fraud are found.

The business case should then list all the benefits that can be expected from the investment. In doing so, it is important that benefits are associated with the business problem or opportunity being addressed, as well as the respective strategic goal(s) in question. User input during this stage can be valuable in terms of providing support for the justification, especially in terms of the proposed benefits. While benefits are both tangible and intangible, findings suggest that both play an important role in the justification process. As such they need to be listed and categorised as financial, quantifiable, measurable, or observable. Further, the business case must outline how they will be measured. This is because quantified benefits are then used to derive the ROI, which in many ways is the deciding factor when assessing if an investment is prudent or not.

Before a ROI measure can be derived however, the business case needs to provide a comprehensive list of the costs that will be incurred. Potential costs for instance, could include hardware / software purchases, training, consulting, system design and programming, and those associated with making necessary business changes. Findings suggest that many of the costs required for technical components may not necessarily be understood by the business. It is therefore important to have both business and IT users during this phase in order to bridge the gap of understanding. In addition, it is important to carry out a risk assessment which should address both risks of implementing and not implementing the proposed system. Risks can be organizational, such as user resistance and change management oriented, and technological, such as technology maturity, compatibility of existing architecture, and complexity of the technology.

At this point, there should be a sufficient basis from which to calculate a ROI figure for the proposal. In doing so, it must be clear how the figure was derived, and how it will be measured down the line. It should also state exactly what it will achieve for the organization; for instance, an increase in revenue or a decrease in cost. Findings suggest that it is advisable for ROI figures to remain conservative due to the risk of falling short of targets. This will also help to secure trust for future proposals. Ideally, the ROI figure should be able to answer the main question of the proposal: is it worth implementing the proposed real-time BI system?

Review: After the business case has been submitted to the relevant stakeholders / investment committee, it will be reviewed for validity of the problems / opportunities being addressed, and whether or not it is actually prudent. The success of this phase is likely to rely on how thoroughly the framework has been followed to this point. Practitioners however, need to also bear in mind that the proposal is likely to be competing for resources with other bids. Therefore, if it is not approved at this stage, the business case may need to be re-worked (as indicated by the feedback link on the diagram).

Approval and Post Approval: After successful buy-in has been achieved, including both business and technical approval, there are several issues that still lie ahead. While these are out of the scope of this research, they will briefly be discussed. First, it is likely that a more detailed and specific design plan will need to be put together. After these preliminary steps, the building / installing and testing phase is expected to be a major task for IT, and will therefore require additional planning, management and coordination. Furthermore, adequate attention should be paid to the preparation for implementation; for instance, it may require training and change management practices, particularly at lower levels where users are not accustomed to using analytical environments for decision-making. Finally, it is anticipated that the deployment of the system will also require significant planning. It is advised that a staged approach be adopted during this process; for instance an initial product in a single business area. In doing so, deployment can be nurtured on a smaller scale in order to ensure that business benefits are being realized; this will particularly be important during post-deployment review.

Approval has potential impact right across the enterprise, although initial applications may be departmental or localized to certain processes. So promotion of the right-time or real-time BI concept and the benefits already (being) achieved should be carried out across the organization. At the same time, existing applications should be monitored and feedback obtained to ensure ongoing improvement in real-time BI organizational deployment.

Overall, this discussion presented provided substantial evidence to derive and support the proposed model. Finally, the following chapter presents the concluding remarks of the study.

Chapter 7 – Conclusion

This chapter serves to provide the concluding remarks of the thesis, including the key research findings, a brief reflection of the research process and limitations, the implications and recommendations, and lastly, suggestions for further research opportunities.

The purpose of the research was to investigate the field of real-time business intelligence and to formulate a model which offers a set of guidelines to assist organizations wanting to implement it. The model does not focus its attention on deployment, rather vital knowledge that an organization needs to know prior to that; thus the intention is to better facilitate the approval process. To do so, it was driven by four questions which aimed to understand technological and organizational challenges of real-time BI implementation, its application areas and related analytics, how it can be justified as an investment, and what influence it has on its users. The literature, analysis, and discussion produced a number of findings that assisted in answering the research questions, and ultimately achieving the desired objective.

This thesis found significant evidence to support claims that real-time BI implementation is associated with complexity surrounding the required technical components, changes to the business environment, and high costs. These are issues that can compromise the success of such a project if they are not properly understood and planned for. It is also evident that real-time BI is already being applied to numerous areas in industry, and that process intelligence is a key component behind many of the analytics.

While literature states that BI justification is difficult to do, given the scale of the project and nature of its benefits, a possible reason for this perception is that investment proposals are not being built in a manner that explicitly describe measurable business problems or opportunities that support strategic objectives, which can subsequently be solved with real-time BI. Another likely explanation is that development is being proposed on too large a scale, which is significantly more difficult, expensive, and less likely to be approved. Therefore, it is believed that the proposed model in Figure 13 (Roadmap for real-time BI implementation planning) can eradicate many of the concerns around the complexity of implementing a system of this nature, and can ultimately assist practitioners in producing meaningful and insightful justification for real-time BI.

7.1 Summary of Findings

Literature suggests that the demand for real-time BI is growing as organizations want quicker access to key information, to react faster to business events, to take proactive responses, to see the current state of the business in relation to business objectives, and the ability to automatically adapt to the changing business environment (Ranjan, 2008; Ranjan, 2005; Seufert & Schiefer, 2005; Venter, 2005; Azvine *et al*., 2005). Traditional BI architecture however is unable to fulfill these requirements; this is mainly because it is geared to analysis of historic data, and cannot provide the ability to link action back into business processes (Azvine *et al*., 2005).

While real-time BI can overcome the limitations of traditional BI, its deployment in industry is said to be hindered due to a lack of clarity surrounding the underlying technical components and the significant costs associated with its implementation (Agrawal, 2009). Some of the implementation challenges include the need to change and re-engineer business processes, enabling a continuous and enterprise-wide integration of data, acquisition and implementation of new tools and technologies, user training, and the difficulty of calculating ROI in order to justify the high costs associated with its implementation (Kilcourse & Rosenblum, 2008).

The intangible nature of BI benefits makes it challenging to justify because it is difficult to demonstrate financial value, thus compromising the validity of ROI calculation (Lönnqvist & Pirttimäki, 2006). As such, several IT evaluation methods were reviewed, including the balanced scorecard approach (Kaplan & Norton, 2008), Porter's value-chain analytics framework (Elbasahir *et al*., 2008), and Soh and Markus' (1995) process theory of how IT creates business value. Although these benefits measurement techniques attempt to address the challenge of measuring benefits, especially those of an intangible nature; each has its limitations and there is still no standard method. Therefore, further review of literature included a business case framework for IT justification (Ward *et al*., 2008) as well as the application of BI maturity models: Williams and Williams (2007) business information maturity model and Eckerson's (2009) TDWI model.

In light of this, there was enough evidence to support the intended direction of the thesis (stated in the opening paragraph of this chapter). Ultimately, the analysis examined and supported the issues that, through the literature, have been highlighted as having an influence on restraining real-time BI justification and implementation. New aspects however, were also discovered, which were then incorporated into the findings. Dominant aspects include the need for a message-bus or communications channel, analytical environments (such as ODS), data-related requirements, issues around integration, as well as organizational requirements; namely, business rule and data definitions, change management practices, and development of users skills (particularly at the operational level). Most of these findings were also consistent with phases of BI maturity, as proposed by Eckerson (2009), thus supporting the need to assess both technological and organizational readiness.

The contribution of this research is therefore the theory itself, which contributes to the field of BI and more so, real-time BI. Furthermore, it has added substance to the business case framework suggested by Ward *et al.* (2008) as well as the TDWI maturity model (Eckerson, 2009). The primary contribution however, is the proposed model, as this provides both tangible value for practitioners, and future research opportunities for academia.

7.2 Reflection on Research Process

In reflection, the qualitative and interpretive nature of the chosen research approach was found to be suitably appropriate for this study for several reasons. It allowed more knowledge and understanding to surface from the interviews, which resulted in a richer understanding of the phenomenon. Many of the findings were not directly addressed in the questions, but rather emerged through conversation. This gave new insight and therefore supported the exploratory intentions of the study. It is the opinion of the researcher that a quantitative survey approach would have limited the findings and would have perhaps uncovered a more shallow understanding of the phenomenon in question.

There were several difficulties in conducting this research which need to be discussed. Firstly, it was not easy to find many organizations that applied real-time BI. More so, some said that they apply real-time BI, but in reality were using more traditional BI systems. In several cases, it was also difficult to incentivize organizations to participate in the research, thus resulting in a smaller sample group. Furthermore, after analysis was complete, it became evident that the scope of the research was perhaps quite large; this resulted in a larger thesis and subsequently required more time to complete. On the other hand, it may have shed light on new concepts and drawn attention to areas that warrant future research.

The main limitation of the study was its sample size. Although it was justified at the research design phase, some of the new concepts and ideas which emerged were only mentioned by a small group. As such, this could compromise generalizability. For this reason, it should be tested for generalizability in future research. Another limitation is that the context of the study was solely in the South African environment; similar concerns regarding generalizability can be said about this. Lastly, the participants involved were mainly in senior positions; the research would have liked to interview more direct users (as stated in the research design), especially at operational levels of the organization. They may have elicited different responses and shed further insight into the use of real-time BI.

7.3 Implications and Recommendations

The findings have several implications for BI practitioners, IT professionals, executive personnel, and academics.

Organizations need to realize that, because BI is typically an enterprise-wide business function with an extensive and complex technological architecture, they should look to establish BI departments or BI competency centres that are exclusively focused on delivering BI solutions. Although this is applied in many organizations, it is important to emphasize that the development of skills in this area will allow practitioners to focus on maturing BI and harnessing its potential value, given the requirements of the organization. This would also facilitate the transition into real-time BI.

Those who want to make a case for real-time BI in their organization however, need to also realize that it will only be considered on the merits of a strong business case which is supported by a tangible value proposition. From a practical perspective, this study recommends that practitioners should adhere to the guidelines set out in the proposed model (Roadmap for real-time BI implementation planning). Emphasis is placed on the importance of articulating the business problem / opportunity that is being solved, and how it supports strategic business objectives. Since many organizations have existing BI architecture, conducting a maturity assessment is a useful method to determine what change is required to achieve the desired environment. Furthermore, it is advised that the project is undertaken at a micro level first, this could be a particular department or business function, in order to demonstrate value relatively quickly. By demonstrating value through realizing benefits, the system can then be expanded to other areas of the organizations, and ultimately to an enterprise-wide level.

The benefit of applying this approach is that it may help to increase the deployment of real-time BI systems and possibly other IT investments too. In addition, this may help to reduce the lack of understanding of real-time BI from a technical perspective (Ioana, 2008).

Berthon, Pitt, Ewing, and Carr (2002), amongst others, affirm that theory development and knowledge creation should include replications, extensions, and generalizations; this not only provides new insight, but it adds to the existing body of knowledge. The findings of this research were closely tied to Eckerson's TDWI model (2009); elements of this model were therefore incorporated into the proposed model. Similarly, the business case framework proposed by Ward *et al.* (2008) correlated with many of the findings of the research, and was also applied to the model. For these reasons, the research has uncovered some possible areas of future research.

7.4 Suggested Future Research

Further research is required to test the validity and generalizability of the findings suggested in this research. In doing so, it may be beneficial to try a combination of statistical, quantitative and qualitative approaches. Due to the local context of the study, it would also be important to replicate it on an international level with a larger sample group. In addition, further research could be conducted with different groups of participants, with emphasis on operational users.

There are also two streams of possible extension; firstly whether the model can be extended to include a post-justification focus, in terms of technical and organizational deployment of real-time BI. This would have significant merit as it would complete the lifecycle of the suggested investment process. Secondly, it would be useful to assess whether the model can be extended to other IT investments, not only real-time BI.

Overall, it is believed that this certainly is a fruitful area for research as real-time BI will continue to grow given the increasing demand for quick access to key information, and the need for intelligent systems that have the ability to adapt to their internal and external environment.

7.5 Concluding Remarks

Finally, this research has indicated that real-time BI implementation is not exempt from the difficulties of IT investment justification. A system of this nature is likely to require significant changes to the technological architecture, as well as changes at a business level; all of which contribute to the associated high costs of its implementation. Nevertheless, real-time BI has the ability to offer significant and measurable improvements, help organizations remain competitive, and in the long run, drive strategic business objectives from a grass roots level.

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Interview Quotes References

These are quotes from the interviews that were used to reference the write-up but which were not directly included.

Code	Quote	Company
TC14	*… we're actually outside of the business process, so business can still continue*	Co2
TC15	*… [we have] multiple platforms*	Co2
TC23	*The majority of organizations you go into all have flat file based kind of integration-which is kind of at night. We're talking now about the retailers, bankers*	Co3
TC30	*… where there is flat files is we've broken it down into messages which flow through and we re-assemble the files on the other side*	Co3
TC36	*… we had to kind of build a pick-up service that runs on the tills and intercepts the transactions to bring them down*	Co3
TC40	*… the integration doesn't affect the workings of the system*	Co3
TC50	*You've also got to select a master data management environment and the technology you're going to use for your database management side.*	Co3
TC71	*In-memory is nothing more than indexing of that transactional system and that indexing happens constantly*	Co4
TC81	*… our systems are highly de-segregated and non-integrated; that's one of the challenges we've had*	Co5
TC91	*So within the business we have to make sure that we've define what on-time means*	Co5
TC94	*… to do analytics on it, it needs to be structured in some way . The thing is you know how you get these simple tools like I don't know if you've heard of Wurdle, those kinds of things. It's like rich text analytics*	Co1
OC16	*… this specific vendor…we had a Gartner review also, they're so far ahead in terms of maturity in this specific area*	Co2
OC37	*… some of the vendors like SAP will say they have got everything, but they don't*	Co3
OC64	*… we can't kind of create little silos of information in certain areas, in sort of service-level areas, we have to bring that information across*	Co3
A48	*… if you don't see any of them going through the till, and you've had them consistently 20 per hour for 3 months, then you don't see any for 3 hours, you don't have to look at the stock ledger-you know that they have a shelf-gap situation which could mean a stock-out or it could just mean its sitting in stocks at the back*	Co3

A107	*… example in the Airline industry there is a big measure of on-time performances: are your planes arriving on time. As a customer, if your plane is 10 minutes late, you would consider it late. But from a Comair perspective and an industry perspective, anything within 15 minutes is considered on-time*	Co5
I19	*… intangible ones, like staff motivation, business knowledge*	Co1
I20	*Also staff motivation and engagement are also softer measures*	Co1
I21	*Return on Investment type model looking at and using the sort of hurdle rates that for us as an organization that were aiming for in terms of investment*	Co1
I22	*… taking our cost of capital into account and the risk of our business etc and because we were using our own skills to develop the system, the cost of those skills in developing this system versus working on a client project and earning revenue*	Co1
I28	*CIO, vendor, system owners, forensic experts, process owners, and business analysts*	Co2
I30	*The second part was technical approval*	Co2
I31	*There were two steps, one was to get the money*	Co2
I59	*… we're always very conservative on our ROI*	Co3
I60	*… conservative about the impact of it, they become more trusting on your submissions of expenditure when you have your ROI calculation*	Co3
B48	*take what has happened in the first week and expand it out forward for the remainder of the month . It allows people to be a little bit more proactive in that they can see that, if they continue on their current trend, they will not achieve their budget and therefore not reach the target in their performance contract*	Co4
U14	*… typically you need the transaction data (the payment transaction) and something about the policy, the policy owner,.. at times you need the inception data. So it depends on what scenario you're looking at*	Co2
U15	*… depends on the hypothesis being looked at, but often the forensic analyst would require all available transactional and geographic data from a business area*	Co2
U25	*The key ideology that I implement is that we never ever push any information to anybody*	Co3
U32	*We even do BI on our own BI*	Co3

Table 12- References of additional Interview Quotes

Appendix

1. **Where in your business is real-time BI being used / or looking to be applied?**
   - What types of analytics are being applied?
   - Data: What data does it use? What are your requirements for data latency?
   - Is it able to drive operations / business processes?
2. **What factors influenced the decision to adopt real-time BI?**
   - How was it done before?
   - What would you say the major benefits are?
3. **What challenges and considerations, both technological and organizational, were faced when implementing / planning for real-time BI?**
   - Technological
     - How was real-time enabled?
     - Did the architecture have to be supplemented?
4. **What goes into the planning and approval of a real-time BI investment?**
   - Did you build or buy a solution?
   - Which stakeholders or parties are involved in the process?
   - How was approval obtained?
   - Were financial measures used?
     - How were they applied?
     - How did they affect the approval process?
     - If not, were any alternative measures taken to overcome this?
   - Were any of the proposed benefits intangible?
     - If so, how did they affect the approval process?
     - Did you attempt to quantify them?
5. **How has the system affected the users, particularly in decision-making?**
   - At strategic, tactical and operational levels?
   - How do their data requirements vary?
   - Do you deploy dashboards?
   - How do you ensure participation?
6. **Do you have any ideas or comments on the use of real-time BI in your organization or elsewhere?**

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Dd/mm/yyyy

Masters Dissertation Research: Participant Consent Form

Dear Sir / Madam,

As an Information Systems Masters student at the University of Cape Town, I am completing a study surrounding Real-time Business Intelligence.

As part of the research process I will be conducting interviews to gain qualitative insights from organizations that are implementing / have implemented a Real-time Business Intelligence system. More specifically, I am interested in the activities that took place prior to implementation. Namely, the factors that influenced the decision to adopt, the challenges and considerations, user-related aspects, and how it was approved as an investment. Your participation in this research will be greatly appreciated.

The interview and interview questions have been approved by the UCT's "Ethics in Research" committee. Participation is completely voluntary and all data collected will be stored electronically and will be kept strictly confidential. The results will be kept anonymous and will only be published as part of the research. However, if you are willing to receive a copy of the final results of the research, you are welcome to request it.

If you have any further queries, please feel free to contact either the researcher or Professor Mike Hart. Contact details are provided below.

Thank you for your time and cooperation.

Sincerely,

Masters Student | Kiril Dobrev kiril.dobrev@uct.ac.za

Supervisor | Mike Hart mike.hart@uct.ac.za

Department of Information Systems

University of Cape Town

PARTICIPANT CONSENT FORM

By signing this participant consent form, you are agreeing to participate in the research project entitled “Investigating the phenomenon of real-time business intelligence and prescribing how to succeed in such an investment”.

Signature: ………………………………………

Date: ……………………………………………

Interview #	3	Participant's title	BI & Integration Manager
Company Code	Co3	Date	3/5/2011
Country	South Africa	Duration	58:48

Me: To get right to it, could you tell me a little about where real-time BI is applied in [company name]?

Interviewee: It's kind of a phased approach; you can't just go real-time on everything because you're totally dependent on your ERP systems that are feeding you the transactions. Are you familiar with an Enterprise Service Bus (ESB), do you understand the concepts behind it?

Me: I do somewhat but could you explain…

Interviewee: And Service Oriented Architecture (SOA)?

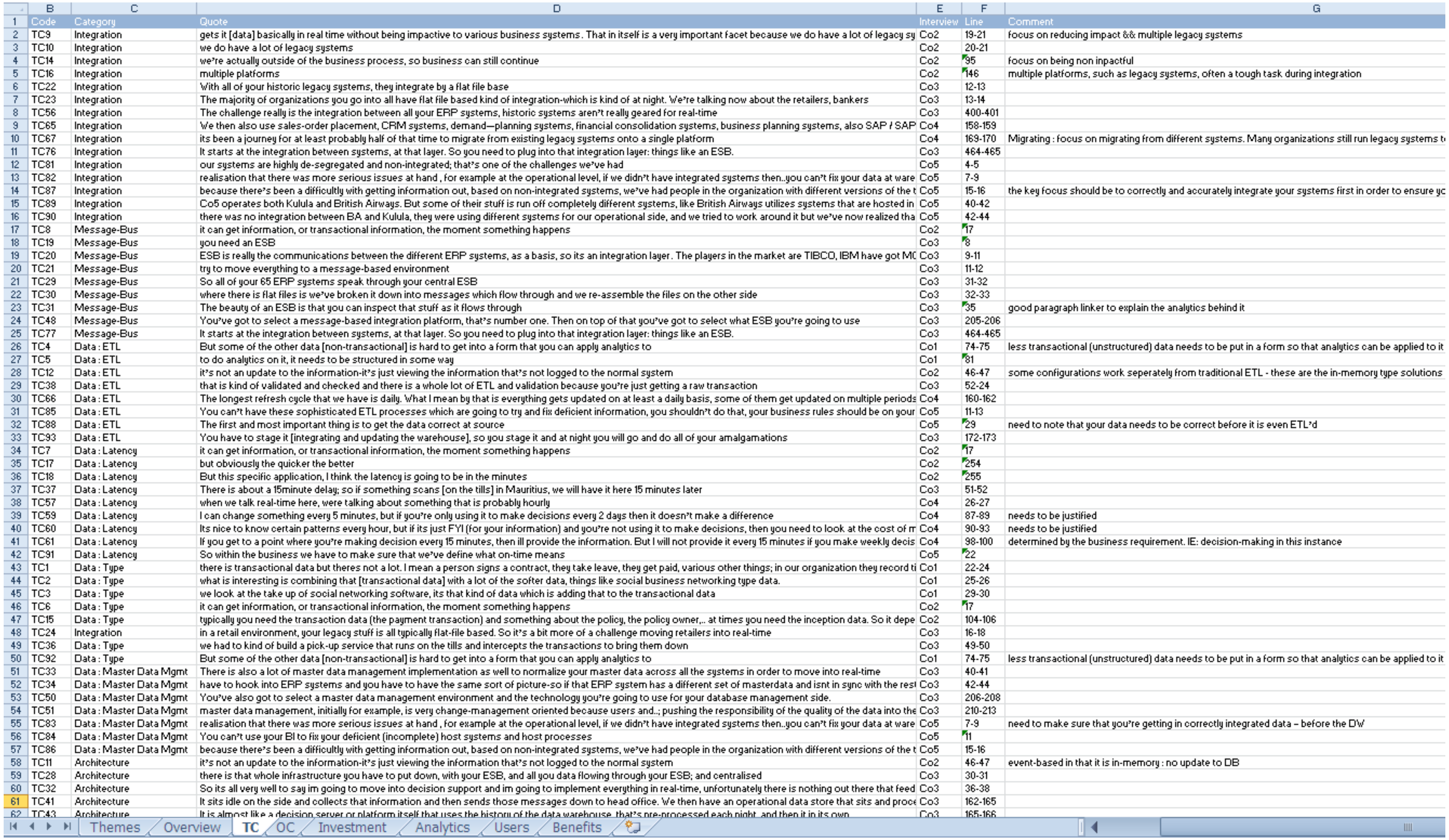
Me: Yes I am

Interviewee: So most environments, if you're going to move into a SOA, you need an ESB, a SOA dictionary where all your services are registered, etc. An ESB is really the communications between the different ERP systems, as a basis, so it's an integration layer. The players in the market are TIBCO, IBM have got MQ and Message Broker which has been around for years. They try to move everything to a message-based environment. With all of your historic legacy systems, they integrate by a flat file base. The majority of organizations you go into all have flat file based kind of integration-which is kind of at night. We're talking now about the retailers, bankers, etc. In certain areas of the banking world its message-based real-time and also in telecommunications and that sort of stuff it's also quite message-based; so it depends on the industry. But in a retail environment, your legacy stuff is all typically flat-file based. So it's a bit more of a challenge moving retailers into real-time. I have kind of been responsible for the decision support. Obviously we've put in the traditional data warehouse which we've had for a number of years now and is really mature. That's all kind of done and dusted. But the majority of that, until about 18 months ago was all nightly loads, and the majority of decision support systems that you'll see in BI platforms are nightly-based. So whatever you see in the morning is the stock on hand or whatever the position was last night. The first thing I did was to take over the integration, and this was to move into the real-time BI space. We implemented an ESB, began breaking up and re-organizing the integration between all the ERP systems. So here they are 65 different ERP systems that run this business. A huge amount of dirty work has to be done to move all of the systems to better integration so that you at least know when systems have integrated, even if it is flat-file based, and to create that infrastructure. Then you need to start monitoring all of that, so you have a business activity monitoring layer which says 'yes you can use the information in this system to make decisions because it has integrated with the other system over night. So there is that whole infrastructure you have to put down, with your ESB, and all you data flowing through your ESB; and centralized. So all of your 65 ERP systems speak through your central ESB, and what we've done where there is flat files, is we've broken it down into messages which flow through and we re-assemble the files on the other side. We'll break it up into what makes logical sense like a set of transactions per store instead of one massive file for 900 stores. The beauty of an ESB is that you can inspect that stuff as it flows through, and then you try and move the systems more towards real-time. So it's all very well to say I'm going to move into decision support and I'm going to implement everything in real-time, unfortunately there is nothing out there that feeds you real-time. It's like buying a Ferrari and you're a farmer and have no road to drive it on. That's kind of a basis to give you; we've had to build kind of a foundation which is a huge project that takes a while. There is also a lot of master data management implementation as well to normalize your master data across all the systems in order to move into real-time. To move into real-time you sometimes have to hook into ERP systems and you have to have the same sort of picture; so if that ERP system has a different set of master data and isn't in sync with the rest, you can end up giving the wrong information, which is also quite key. Anyway, that's all the groundwork.

The first thing we did was, I took the Point of Sale (POS), so the most value in terms of a retailer is that if you can see what's happening at the POS in sort of split seconds, then you know what's happening. So the strategy has been to move into POS real-time then move towards receipting and all the other disciplines from a real-time decision support perspective. So we've got a product called Retailex in our POS, custom built, but we had to kind of build a pick-up service that runs on the tills and intercepts the transactions to bring them down. So we had to replace the whole way they communicate with a new mechanism. There is about a 15 minute delay; so if something scans in Mauritius, we will have it here 15 minutes later. And that is kind of validated and checked and there is a whole lot of ETL and validation because you're just getting a raw transaction. With real-time on your till, we've been able to do things like shelf-gap monitoring, so you can monitor stock-out situations because your stock ledgers aren't always accurate. But you can take a subset of your goods that flow through your tills at an average rate per hour. Say a 2 litre coke; you will see.. say 20 up to 50 of these things, every hour, going through the till. Then you look at it over, let's say a 3 month period, and its consistent with some slight variation; but if you don't see any of them going through the till, and you've had them consistently 20 per hour for 3 months, then you don't see any for 3 hours, you don't have to look at the stock ledger, you know that they have a shelf-gap situation which could mean a stock-out or it could just mean its sitting in stocks at the back. Now for in stock, for retailers, that's a massive advantage to understand, centrally, what your shelves looks like and then measure that and also re-organize your supply chain according to those performance measurements, that KPI. That's said to be the first thing we've delivered to the business and its been in place for about a year now; it gave us an insight into the business, not only in shelf gap things, but also in the way we pack our goods away, the way we replenish the shelves, the type of things we use, in terms of gondolas and stuff in the stores, the type of shelf space. There's all types of examples where we use incorrect things: for potatoes, loose potatoes sell on bags of potatoes which are a very high-volume seller and people were too scared to move them because the potatoes would fall. Silly things like that that you don't really see before. So that whole thing, and obviously there's lots to learn, I mean as you move, and are now receiving information you can monitor with real-time, you start to learn more about the business because you get different visibility on the business. And there's other stuff like fraud monitoring that we're busy with at the moment so we can react immediately when we ... there's certain things that they do that you can pick up in transactions.

Me: That's actually an interesting take on where real-time analytics is starting to be used quite a lot. And, with the real-time system that you have in place, specifically for the POS, how much of it links to business processes and is automated? Like self-made decisions for example.

Interviewee: Look, self-made decisions and those sorts of things we do on a daily basis, we do like auto-prediction; but you have to do like mega processing, we not doing that kind of thing split-second. I'm sure that at some stage, we'll move to that, the first step would have been now that we can monitor shelf-space we could check for stock level, we could re-order immediately. But we're not quite there, I mean, just auto-prediction itself, in terms of implementation, not from a systems perspective, but from a perspective of change-management with people and the trust of those predicted orders is quite a slow process, so we started off about 4 years ago with auto-prediction…



Row	Code	Category	Quote	Interview	Line	Comment
2	TC9	Integration	gets it [data] basically in real time without being impactive to various business systems. That in itself is a very important facet because we do have a lot of legacy sy	Co2	19-21	focus on reducing impact && multiple legacy systems
3	TC10	Integration	we do have a lot of legacy systems	Co2	20-21	
4	TC14	Integration	we're actually outside of the business process, so business can still continue	Co2	35	focus on being non inpactful
5	TC16	Integration	multiple platforms	Co2	146	multiple platforms, such as legacy systems, often a tough task during integration
6	TC22	Integration	With all of your historic legacy systems, they integrate by a flat file base	Co3	12-13	
7	TC23	Integration	The majority of organizations you go into all have flat file based kind of integration-which is kind of at night. We're talking now about the retailers, bankers	Co3	13-14	
8	TC56	Integration	The challenge really is the integration between all your ERP systems, historic systems aren't really geared for real-time	Co3	400-401	
9	TC65	Integration	We then also use sales-order placement, CRM systems, demand—planning systems, financial consolidation systems, business planning systems, also SAP / SAP	Co4	158-159	
10	TC67	Integration	its been a journey for at least probably half of that time to migrate from existing legacy systems onto a single platform	Co4	169-170	Migrating : focus on migrating from different systems. Many organizations still run legacy systems t
11	TC76	Integration	It starts at the integration between systems, at that layer. So you need to plug into that integration layer: things like an ESB.	Co3	464-465	
12	TC81	Integration	our systems are highly de-segregated and non-integrated; that's one of the challenges we've had	Co5	4-5	
13	TC82	Integration	realisation that there was more serious issues at hand , for example at the operational level, if we didn't have integrated systems then..you can't fix your data at ware	Co5	7-9	
14	TC87	Integration	because there's been a difficultly with getting information out, based on non-integrated systems, we've had people in the organization with different versions of the t	Co5	15-16	the key focus should be to correctly and accurately integrate your systems first in order to ensure yo
15	TC89	Integration	Co5 operates both Kulula and British Airways. But some of their stuff is run off completely different systems, like British Airways utilizes systems that are hosted in	Co5	40-42	
16	TC90	Integration	there was no integration between BA and Kulula, they were using different systems for our operational side, and we tried to work around it but we've now realized tha	Co5	42-44	
17	TC8	Message-Bus	it can get information, or transactional information, the moment something happens	Co2	17	
18	TC19	Message-Bus	you need an ESB	Co3	8	
19	TC20	Message-Bus	ESB is really the communications between the different ERP systems, as a basis, so its an integration layer. The players in the market are TIBCO, IBM have got MC	Co3	9-11	
20	TC21	Message-Bus	try to move everything to a message-based environment	Co3	11-12	
21	TC29	Message-Bus	So all of your 65 ERP systems speak through your central ESB	Co3	31-32	
22	TC30	Message-Bus	where there is flat files is we've broken it down into messages which flow through and we re-assemble the files on the other side	Co3	32-33	
23	TC31	Message-Bus	The beauty of an ESB is that you can inspect that stuff as it flows through	Co3	35	good paragraph linker to explain the analytics behind it
24	TC48	Message-Bus	You've got to select a message-based integration platform, that's number one. Then on top of that you've got to select what ESB you're going to use	Co3	205-206	
25	TC77	Message-Bus	It starts at the integration between systems, at that layer. So you need to plug into that integration layer: things like an ESB.	Co3	464-465	
26	TC4	Data : ETL	But some of the other data [non-transactional] is hard to get into a form that you can apply analytics to	Co1	74-75	less transactional (unstructured) data needs to be put in a form so that analytics can be applied to it
27	TC5	Data : ETL	to do analytics on it, it needs to be structured in some way	Co1	81	
28	TC12	Data : ETL	it's not an update to the information-it's just viewing the information that's not logged to the normal system	Co2	46-47	some configurations work seperately from traditional ETL - these are the in-memory type solutions
29	TC38	Data : ETL	that is kind of validated and checked and there is a whole lot of ETL and validation because you're just getting a raw transaction	Co3	52-24	
30	TC66	Data : ETL	The longest refresh cycle that we have is daily. What I mean by that is everything gets updated on at least a daily basis, some of them get updated on multiple periods	Co4	160-162	
31	TC85	Data : ETL	You can't have these sophisticated ETL processes which are going to try and fix deficient information, you shouldn't do that, your business rules should be on your	Co5	11-13	
32	TC88	Data : ETL	The first and most important thing is to get the data correct at source	Co5	29	need to note that your data needs to be correct before it is even ETL'd
33	TC93	Data : ETL	You have to stage it [integrating and updating the warehouse], so you stage it and at night you will go and do all of your amalgamations	Co3	172-173	
34	TC7	Data : Latency	it can get information, or transactional information, the moment something happens	Co2	17	
35	TC17	Data : Latency	but obviously the quicker the better	Co2	254	
36	TC18	Data : Latency	But this specific application, I think the latency is going to be in the minutes	Co2	255	
37	TC37	Data : Latency	There is about a 15minute delay; so if something scans [on the tills] in Mauritius, we will have it here 15 minutes later	Co3	51-52	
38	TC57	Data : Latency	when we talk real-time here, were talking about something that is probably hourly	Co4	26-27	
39	TC59	Data : Latency	I can change something every 5 minutes, but if you're only using it to make decisions every 2 days then it doesn't make a difference	Co4	87-89	needs to be justified
40	TC60	Data : Latency	Its nice to know certain patterns every hour, but if its just FYI (for your information) and you're not using it to make decisions, then you need to look at the cost of m	Co4	90-93	needs to be justified
41	TC61	Data : Latency	If you get to a point where you're making decision every 15 minutes, then ill provide the information. But I will not provide it every 15 minutes if you make weekly decis	Co4	98-100	determined by the business requirement. IE: decision-making in this instance
42	TC91	Data : Latency	So within the business we have to make sure that we've define what on-time means	Co5	22	
43	TC1	Data : Type	there is transactional data but theres not a lot. I mean a person signs a contract, they take leave, they get paid, various other things; in our organization they record ti	Co1	22-24	
44	TC2	Data : Type	what is interesting is combining that [transactional data] with a lot of the softer data, things like social business networking type data.	Co1	25-26	
45	TC3	Data : Type	we look at the take up of social networking software, its that kind of data which is adding that to the transactional data	Co1	29-30	
46	TC6	Data : Type	it can get information, or transactional information, the moment something happens	Co2	17	
47	TC15	Data : Type	typically you need the transaction data (the payment transaction) and something about the policy, the policy owner,.. at times you need the inception data. So it depe	Co2	104-106	
48	TC24	Integration	in a retail environment, your legacy stuff is all typically flat-file based. So it's a bit more of a challenge moving retailers into real-time	Co3	16-18	
49	TC36	Data : Type	we had to kind of build a pick-up service that runs on the tills and intercepts the transactions to bring them down	Co3	49-50	
50	TC92	Data : Type	But some of the other data [non-transactional] is hard to get into a form that you can apply analytics to	Co1	74-75	less transactional (unstructured) data needs to be put in a form so that analytics can be applied to it
51	TC33	Data : Master Data Mgmt	There is also a lot of master data management implementation as well to normalize your master data across all the systems in order to move into real-time	Co3	40-41	
52	TC34	Data : Master Data Mgmt	have to hook into ERP systems and you have to have the same sort of picture-so if that ERP system has a different set of masterdata and isnt in sync with the rest	Co3	42-44	
53	TC50	Data : Master Data Mgmt	You've also got to select a master data management environment and the technology you're going to use for your database management side.	Co3	206-208	
54	TC51	Data : Master Data Mgmt	master data management, initially for example, is very change-management oriented because users and..; pushing the responsibility of the quality of the data into the	Co3	210-213	
55	TC83	Data : Master Data Mgmt	realisation that there was more serious issues at hand , for example at the operational level, if we didn't have integrated systems then..you can't fix your data at ware	Co5	7-9	need to make sure that you're getting in correctly integrated data – before the DW
56	TC84	Data : Master Data Mgmt	You can't use your BI to fix your deficient (incomplete) host systems and host processes	Co5	11	
57	TC86	Data : Master Data Mgmt	because there's been a difficultly with getting information out, based on non-integrated systems, we've had people in the organization with different versions of the t	Co5	15-16	
58	TC11	Architecture	it's not an update to the information-it's just viewing the information that's not logged to the normal system	Co2	46-47	event-based in that it is in-memory : no update to DB
59	TC28	Architecture	there is that whole infrastructure you have to put down, with your ESB, and all you data flowing through your ESB; and centralised	Co3	30-31	
60	TC32	Architecture	So its all very well to say im going to move into decision support and im going to implement everything in real-time, unfortunately there is nothing out there that feed	Co3	36-38	
61	TC41	Architecture	It sits idle on the side and collects that information and then sends those messages down to head office. We then have an operational data store that sits and proce	Co3	162-165	
62	TC43	Architecture	It is almost like a decision server or platform itself that uses the history of the data warehouse, that's pre-processed each night, and then it in its own	Co3	165-166	

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	B	C	D	E	F	G
1	Code	Category	Quote	Interview	Line	Comment
2	I8	Stakeholders	a combination of ideas from the business, so you could say the operational head in JHB region, and also the technology team (software development team).	Co1	103-104	good to have both Business side and developers both involved
3	I11	Stakeholders	the actual investment decision, thats being made at a senior level in the organization, what we call our "Strategy and Risk Committee", so that's the Executive Committee	Co1	105-107	
4	I24	Stakeholders	another problem is that we want to keep this undercover but there is a very wide audience that needs to know, you need the architects, the security people, the technical peo	Co2	125-127	emphasis on the decision to limit the audience that needs to know about the system
5	I25	Stakeholders	some of the more traditional database application database knowledge experts that sit in the technical space do not fully understand a business warehouse	Co2	142-143	IT & Bus may struggle to talk the same language
6	I28	Stakeholders	CIO, vendor, system owners, forensic experts, process owners, and business analysts	Co2	166-167	for planning & approval
7	I32	Stakeholders	audience that I had understood the way I formulated the numbers because it was in their language	Co2	177-178	You need both IT and bus input here
8	I33	Stakeholders	they also then wanted to understand the ROI and they [IT] didn't understand the numbers in context	Co2	180-181	IT & Bus different languages
9	I49	Stakeholders	whoever's going to benefit from it. In this case were doing it in the space of operations. So in this case your Chief Operating Officer (COO) is your main component behind i	Co3	236-238	
10	I64	Stakeholders	a lot of IT departments where the IT individuals are not business-oriented at all, they are very technical. They struggle to put forward a strategy and they don't understand the	Co3	283-285	Bus/ IT speak diff languages
11	I65	Stakeholders	there's always that gap of understanding	Co3	286-287	Bus/ IT speak diff languages
12	I66	Stakeholders	The people implementing it need to understand the business	Co3	399-400	emphasis on the need for business knowledge
13	I70	Stakeholders	We have what we call an IS investment committee that your CIO, the financial director, and one or two other directors sit on	Co4	178-179	
14	I72	Stakeholders	investment committee	Co4	184	
15	I85	Stakeholders	So we continuously try to innovate, it's one of the biggest things we try do internally in IT	Co3	245-246	investment ideas are often hatched in the IT space as they try to innovate
16	I1	Build / Buy	were not large, were 150 people, our requirements in terms of data and storage are not very complex, so were building a lot of it ourselves	Co1	17-18	
17	I18	Build / Buy	we turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients	Co1	120-121	source of revenue for s/w dev. Org
18	I23	Build / Buy	taking our cost of capital into account and the risk of our business etc and because we were using our own skills to develop the system, the cost of those skills in developi	Co1	144-146	
19	I27	Build / Buy	this specific vendor...we had a Gartner review also, they're so far ahead in terms of maturity in this specific area	Co2	162-163	choice in vendor should be reviewed, maturity is good
20	I75	Build / Buy	we've realized that we would buy it because were an Airline and not a software development company.	Co5	46-47	
21	I80	Build / Buy	we could sit and work one out ourselves and I could get a team of developers who could build one, but we'd have to whey that up against ..maturing a product internally wher	Co3	95-97	buying vs developing in-house
22	I81	Build / Buy	the thing is there aren't really vendors out there that have got to that level of sophistication	Co3	93-94	vendors have limitations so orgs are sometimes forced to tweak things or build there own
23	I82	Build / Buy	Well there are situations where there is nothing on the market; I mean the real-time POS, there's nothing really on the market that allows us to do it in the fashion we wanted	Co3	216-217	
24	I83	Build / Buy	sometimes the solution is the purchasing of one or two items and plugging them together and coming up with a solution.	Co3	226-228	
25	I84	Build / Buy	some of the vendors like SAP will say they have got everything, but they don't	Co3	230-231	vendors cant always satisfy your business needs
26	I26	Trust	because our forensics team, over the last 5 to 8 years, has really shown a lot of value to business, from what we take and what we give	Co2	153-154	
27	I61	Trust	conservative about the impact of it, they become more trusting on your submissions of expenditure when you have your ROI calculation	Co3	275-276	
28	I76	Trust	The big advantage is that we have complete buy-in from the organization. Everyone realises that BI is a necessary component of the organization.	Co5	128-129	bus realizes that BI is an essential component
29	I79	Trust	there's long term, like architecture, it's quite difficult to put forward and say what is ROI putting down on ESB	Co3	252-254	something like an ESB, in isolation, may not demonstrate financial value but is in essence a crucial compoone
30	I2	Tangible benefits	business case is not that difficult because if we can lower our retention rate, that can be translated directly into the cost to re-hire someone and there's metrics on that	Co1	38-39	
31	I3	Tangible benefits	when someone leaves, the productivity slows down because they're moving on	Co1	40	
32	I4	Tangible benefits	So when it comes to a service industry, professional services,what really makes a difference is when people are putting their discretionary effort into the organization	Co1	40-42	
33	I16	Tangible benefits	talent retention – we can quantify that	Co1	119	
34	I17	Tangible benefits	we turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients	Co1	120-121	source of revenue for s/w dev. Org
35	I21	Financial measures	Return on Investment type model looking at and using the sort of hurdle rates that for us as an organization that were aiming for in terms of investment	Co1	142-144	
36	I22	Financial measures	taking our cost of capital into account and the risk of our business etc and because we were using our own skills to develop the system, the cost of those skills in developi	Co1	144-146	
37	I29	Financial measures	We did give them a ROI number	Co2	176	
38	I34	Tangible benefits	ACFE (American Certified Forensic Examiner Association), they said in 2010 that 5% of a company's turnover was, on average, the amount of fraud. Now we in South Afric	Co2	188-190	also in requirements
39	I35	Tangible benefits	expectations	Co2	192	large focus on keeping expectations modest in order to ensure they can be meet : thus value is demonstrated
40	I36	Tangible benefits	the current process that we have, the reactive one, there is a number of things that we have picked up-and they were happy with that number. But when we bring Intellinx in, we	Co2	193-195	emphasis on tangibility
41	I37	Tangible benefits	I looked at everything that was reported to forensics and from that I isolated the items that I believe a good enough technology that could be picked up [25:10], so that gave	Co2	195-197	
42	I40	Tangible benefits	Timeliness would be, but that I could quantify	Co2	216	
43	I41	Financial measures	we used illustrative values in the [business case]	Co2	219	
44	I44	Tangible benefits	I took the Point of Sale (POS), so the most value in terms of a retailer is that if you can see what's happening at the POS in sort of split seconds, then you know whats happ	Co3	45-47	
45	I45	Tangible benefits	In a retailer's world, you need to understand things like the halo effect of not having 1 item	Co3	143-144	retail : stock – halo effect of not having one good can translate into much wider losses
46	I46	Tangible benefits	they can receive their stock within a 24hour period instead of a 48hour period and keep the in-stock situation higher; so the bottom line is we would be that much more profi	Co3	150-152	Stock : emphasis on its impact to the profit/bottom line
47	I47	Tangible benefits	So the halo effect.., you might say, not having 2litre coke, for R8.50, for 2 hours lost us this amount of money-but you didn't, you lost a hell of a lot of other business as well	Co3	155-157	
48	I53	Tangible benefits	what you do is say : we have to invest in a new foundation, or a new integration platform; these are all the different benefits we will deliver over the years.	Co3	255-257	
49	I55	Tangible benefits	So obviously we had to bring forward the shelf-gap monitoring as quickly as possible	Co3	257	
50	I58	Tangible benefits	always very conservative about the, so we'll say, if were in a 78% in stock situation and I guarantee you if we put you into an 80%, that's a 2% better in stock situation and the	Co3	271-273	focus on being CONSERVATIVE
51	I59	Financial measures	we're always very conservative on our ROI	Co3	274	emphasis on conservative
52	I60	Financial measures	conservative about the impact of it, they become more trusting on your submissions of expenditure when you have your ROI calculation	Co3	275-276	
53	I78	Financial measures	Were too early at this stage to give a tangible measure of the return, we'll probably do that in the next 2 years as we start measuring the impact. Were just too young as an or	Co5	136-138	ROI figures are sometimes realised in the long term without immediate ROI figures
54	I19	Intangible benefits	intangible ones, like staff motivation, business knowledge	Co1	125	
55	I20	Intangible benefits	Also staff motivation and engagement are also softer measures	Co1	126	
56	I38	Intangible benefits	But the biggest win for us is more the new information that is coming to the force so that we could look at what syndicates are doing, so that was my biggest driver	Co2	202-203	
57	I39	Intangible benefits	It's the collection of information that we previously did not have	Co2	213	new info
58	I42	Intangible benefits	via assumptions and history	Co2	220-221	how they can be quantified
59	I43	Intangible benefits	this is more or less the value and I assumed these types we could have picked up	Co2	222-223	these were quantified using assumptions and history
60	I54	Intangible benefits	what you do is say : we have to invest in a new foundation, or a new integration platform; these are all the different benefits we will deliver over the years.	Co3	255-257	
61	I57	Intangible benefits	We don't try to measure any intangible benefits, we would state them	Co3	268	
62	I62	Intangible benefits	you obviously list all of your intangible benefits; but no one is going to sit there and try and measure those	Co3	277-278	

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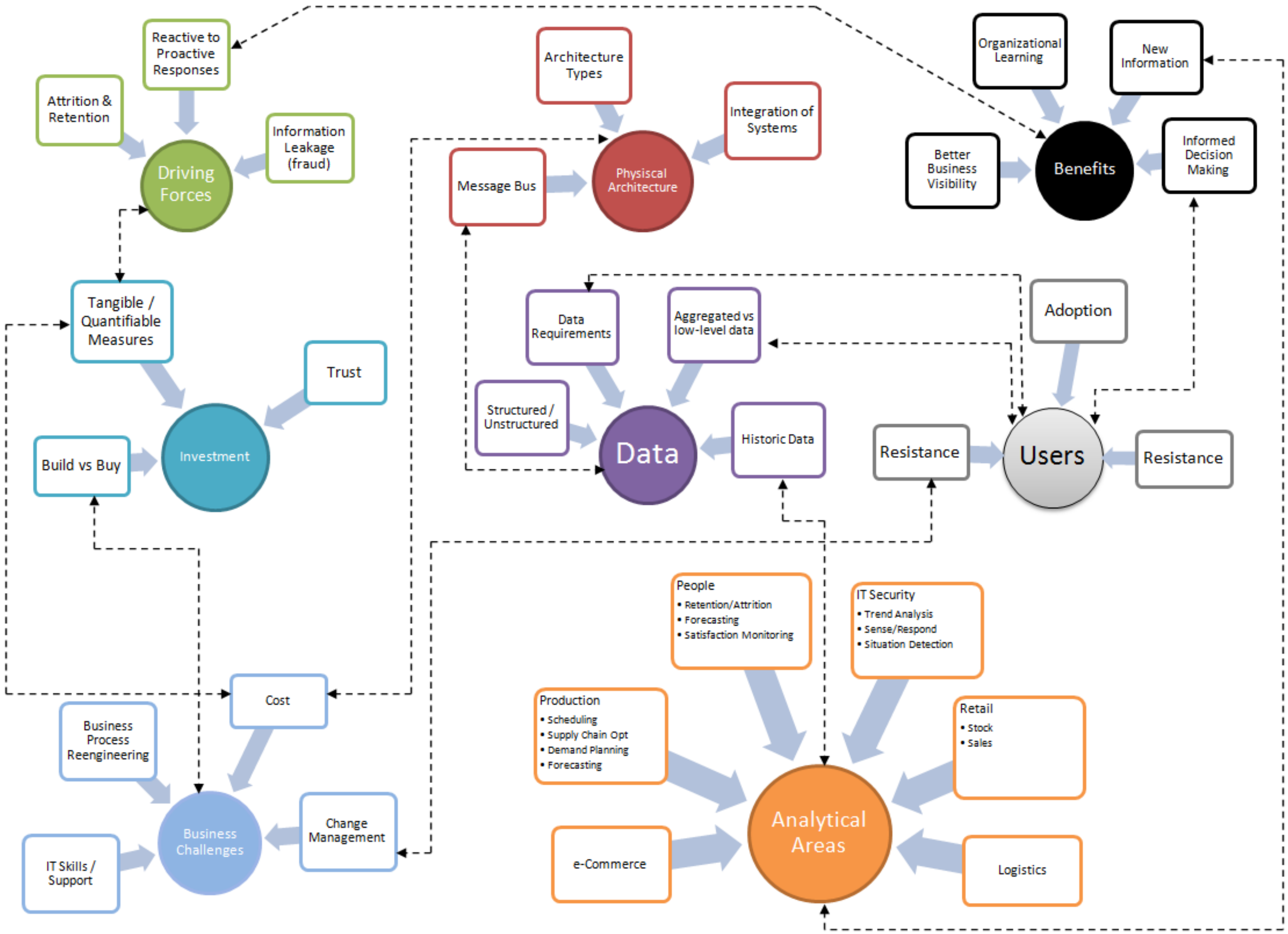
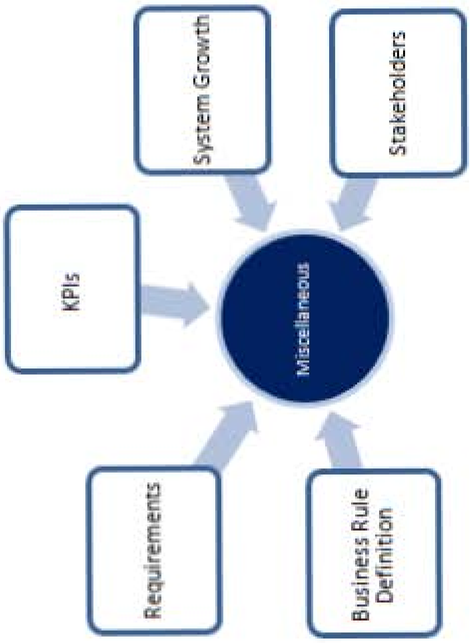
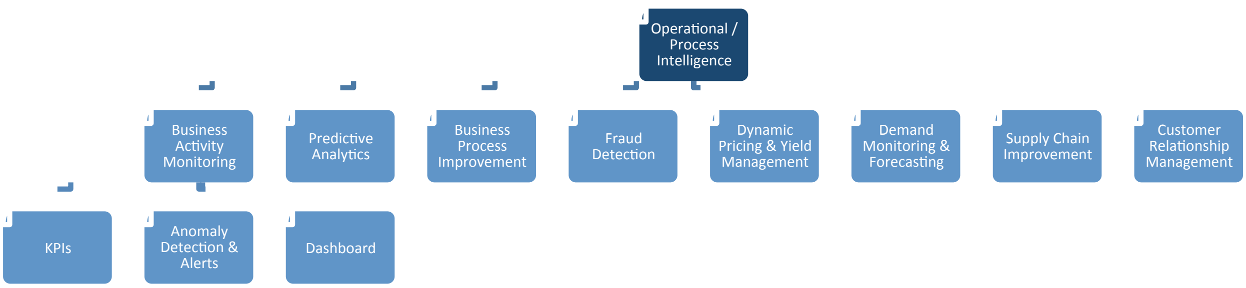
Code	Extract	Coded for
Co1-9-13	*"We'll look at people attrition and retention trends and the way we'll do that is we'll collect data based on when people resign and the reasons behind it and sorts of things … but it's all reactive and so the ideal would be to get those indicators through and things like likelihood to leave, in real-time. Then we can take proactive action."*	• Driving force of investment (Attrition & retention) • Importance of collecting data – used as contextual information • Using data and trends to create indicators (KPIs) • Change from a reactive to proactive response
Co1-103-104	*"It started off small and initially it was a combination of ideas from the business; so you could say the operational head in JHB region, and also the technical team; the software development team."*	• Implement at a micro level (system growth and evolution) • Multiple stakeholder input • Importance of business & IT
Co1-119-121	*"The benefits for us, as I mentioned, would be talent retention. We can quantify that. But also for us, we turn it into a revenue stream as well, so the system and all of its little capabilities is something we started to provide to clients. So that makes it easier for us to justify it."*	• Retention as a driving force for the investment • Quantification of benefits is important for justification • The system becomes a source of revenue (contributes to ROI) • Building system internally versus buying
Co2-233-237	*"The dashboard is something we will employ, but we actually look at it from the granular level … but in forensics we really dig to the lowest level we can go to. There are instances where we aggregate to get an idea or to look at trends or to compare what you see against what has previously happened. But most of the time it is at a detailed level."*	• Low-level versus high-level (aggregated) view of data • Data requirements vary depending on user or business level • Important to collect historic data – for trends, comparisons etc.
Co3-62-67	*"… massive advantage to understand, centrally, what your shelves looks like and then measure that and also re-organize your supply chain … it gave us an insight into the business, not only in shelf gap things, but also in the way we pack our goods away, the way we replenish the shelves, the type of things we use, in terms of gondolas and stuff in the stores, the type of shelf space"*	• Business visibility increased – in store visibility • Business visibility offers several intangible benefits • New information contributes to better insight of the business • Supply chain optimization
Co4-71-73	*"… and obviously there's a lot to learn, I mean as you move, and are now receiving information in real-time, you start to learn more about the business because you get different visibility on the business"*	• New information contributes to better insight of the business – through discovery of things that were before unseen • Contributes to better business visibility

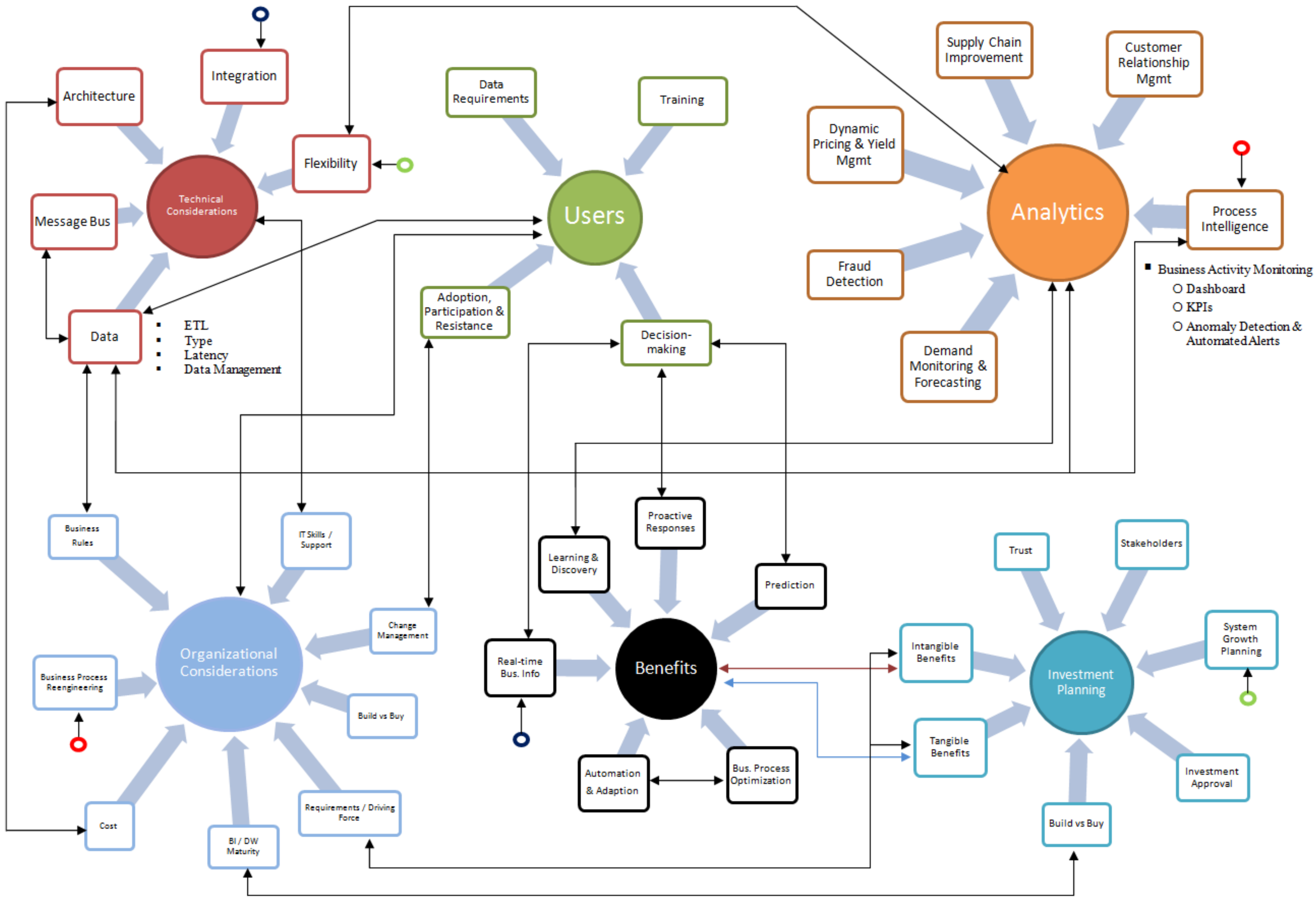
Appendix F | Thematic map (1st Iteration)




Miscellaneous
KPIs
System Growth
Stakeholders
Requirements
Business Rule Definition

Business Function	Analytics Purpose	Coded as
Retail : Stock	Dynamic Pricing	Dynamic Pricing & Yield Management
	Basket Analysis	Customer Relationship Management
	Promotions	Customer Relationship Management
	Replenishment	Operational / Process Intelligence Demand Monitoring & Forecasting
	Forecasting	Operational / Process Intelligence
	Trend Analysis	Operational / Process Intelligence
	Sense & Respond	Operational / Process Intelligence
Retail : Sales	Category Management	Customer Relationship Management Supply Chain Improvement
	Demand Planning	Demand Monitoring & Forecasting Predictive Analytics
	Forecasting	Operational / Process Intelligence
	Trend Analysis	Operational / Process Intelligence
Production	Scheduling	Supply Chain Improvement
	Demand Planning	Demand Monitoring & Forecasting
	Supply Chain Optimization	Supply Chain Improvement
IT Security	Sense & Respond	Fraud Detection Operational / Process Intelligence
	Trend Analysis	Operational / Process Intelligence
	Real-time Situation Detection	Fraud Detection Operational / Process Intelligence
Logistics	Demand Planning	Demand Monitoring & Forecasting
People	Monitoring Satisfaction	Operational / Process Intelligence Business Activity Monitoring
	Retention / Attrition	Operational / Process Intelligence Business Activity Monitoring
	Forecasting	Operational / Process Intelligence Predictive Analytics

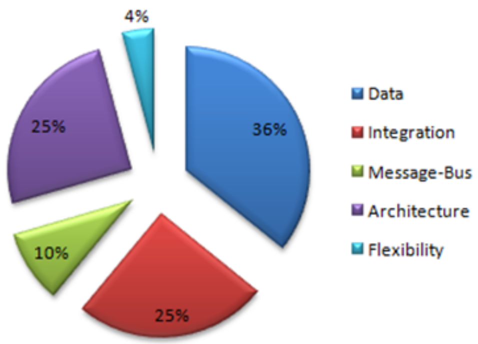




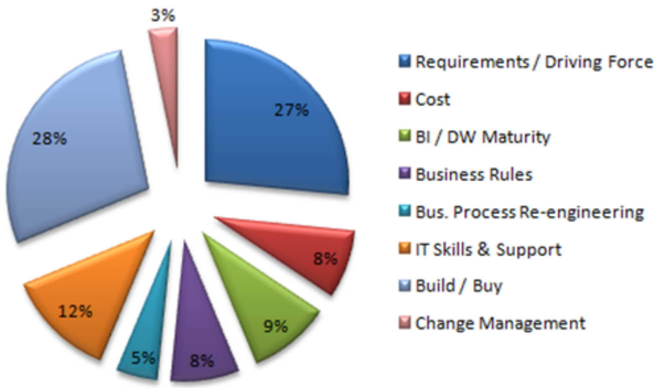
Architecture
Integration
Flexibility
Message Bus
Technical Considerations
Data
ETL
Type
Latency
Data Management
Data Requirements
Training
Users
Adoption, Participation & Resistance
Decision-making
Supply Chain Improvement
Customer Relationship Mgmt
Dynamic Pricing & Yield Mgmt
Analytics
Process Intelligence
Fraud Detection
Demand Monitoring & Forecasting
Business Activity Monitoring
Dashboard
KPIs
Anomaly Detection & Automated Alerts
Business Rules
IT Skills / Support
Organizational Considerations
Change Management
Business Process Reengineering
Build vs Buy
Cost
BI / DW Maturity
Requirements / Driving Force
Proactive Responses
Learning & Discovery
Prediction
Real-time Bus. Info
Benefits
Automation & Adaption
Bus. Process Optimization
Trust
Stakeholders
Intangible Benefits
Investment Planning
System Growth Planning
Tangible Benefits
Investment Approval
Build vs Buy

Appendix I | Pie Charts of Components in Themes

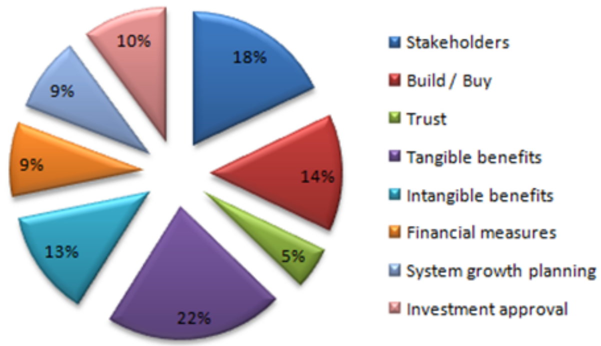
Technological Considerations



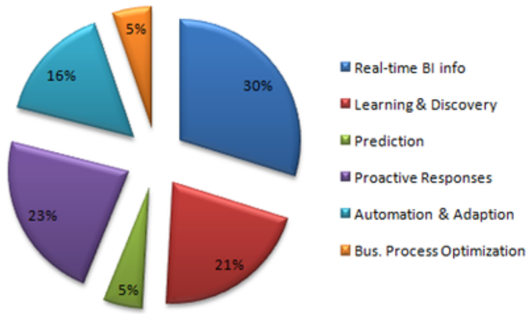
Organizational Considerations



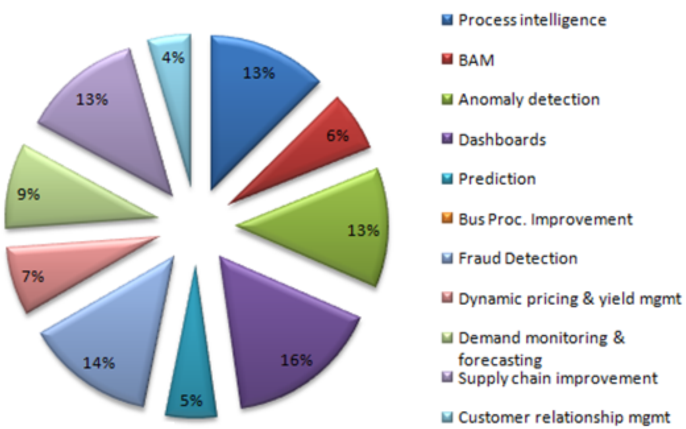
Investment



Benefits



Analytics



Users