Benefits, Justification and Implementation Planning of Real-Time Business Intelligence Systems

Kiril Dobrev and Mike Hart
University of Cape Town, Cape Town, South Africa
kirildobrev@gmail.com
mike.hart@uct.ac.za

Abstract: While traditional Business Intelligence (BI) environments have for some time assisted organizations with their information requirements, they have become increasingly incompatible with the pressures of current business environments. They are geared towards analysis of historical information, and limited in their ability to close the latency gap between information and action. This has encouraged a movement towards real-time BI (RTBI) systems. Although these overcome latency aspects of traditional BI, and offer many value-adding benefits to organizations, their implementation has been hampered by technological complexities, and has required changes to the business environment, and high costs to put them in place. Justification of such IT investments remains a problem as they provide many intangible benefits incompatible with traditional (financial) IT benefits measurement models. For these reasons, the research set out to investigate and understand the technological components and organizational changes surrounding RTBI implementation. To further facilitate justification, application areas and benefits of RTBI were also explored. Data was collected through semi-structured in-depth interviews in organizations across several industries that had implemented or were implementing RTBI systems. A qualitative thematic analysis was then used to investigate the issues further. The study confirmed that RTBI is likely to require major changes to technical architecture, which may involve acquisition of new tools and technologies. Several issues at the organisational level also need to be addressed, and the research uncovered a wide range of practical RTBI applications and analytics applied across industries; process intelligence was found to play a fundamental role in many of these. The study reveals that RTBI can offer significant and measurable improvements, help organizations remain competitive, and in the long run, drive strategic business objectives from a grass roots level. To assist organisations to take advantage of this, a roadmap for RTBI justification and implementation planning is suggested.

Keywords: business intelligence, real-time BI, BI maturity, analytics, process intelligence, operational BI, justification

1. Introduction

For the sixth successive year, Business Intelligence (BI) and Analytics was rated the most important technology and application issue for CIOs (Kappelman, McLean, Johnson, & Gerhart 2014). In this survey Big Data is the 10th most significant IT investment, with data velocity comprising one of its "three Vs" (Pedersen, Castellanos & Dayal 2014; Villars, Olofson & Eastwood 2011). BI and Analytics (BI&A) has consistently been the top IT application and technology investment in Europe, and is globally the "top IT trend keeping the CIO awake at night" (Derksen & Luftman 2014).

Initially storage and processing constraints meant that data for BI was typically kept at a summary level (daily, weekly, monthly etc), and there was a significant time delay (latency) in creating and using these summaries. Transaction-based analytics or data mining was generally not done on real-time data, other than for areas like fraud detection. BI was typically at a strategic or tactical level. Cost-effective advances in storage and processing have now facilitated BI at operational and process levels, with increased interest in real-time BI (RTBI) and analytics. This research aims to uncover many of the issues involved in planning implementions of RTBI systems, by interviewing key people involved in such implementations across a range of organisations.

A brief literature review next summarises key aspects of real-time implementation of BI. Details of the research methodology used then follow. Analysis of the interviews then exposes pertinent issues surrounding justification and implementation of RTBI. After discussion and summarisation of these, a roadmap to help organisations with RTBI justification and implementation planning is developed, and the paper concludes.

2. Background

Figure 1 illustrates the motivation for an organisation to move towards RTBI, suggesting that three different latencies reduce the business value of information (Hackathorn 2004). For example, ETL (extract, transform and load) processing often occurs in overnight batch runs (Seufert & Schiefer 2005). This means that the results of BI and analytics cannot link back into business processes immediately or automatically (Azvine, Cui &

Nauck 2005; Sahay & Ranjan 2008), and provide timely action. Andriole (2012) stresses the need for real-time analytics, while Korotina, Mueller and Debortoli (2015) note the value of real-time business process intelligence, but suggest that understanding of this concept by businesses is limited. When analytical processes are linked in real time to business activity monitoring (BAM), it is possible to take corrective action before problems materialize (Seufert & Schiefer 2005). Reducing action time in order to increase business value is therefore the critical objective for RTBI (Eckerson 2004; Tank 2015). Ioana (2008) sees RTBI as an evolutionary process towards operational BI using process intelligence.

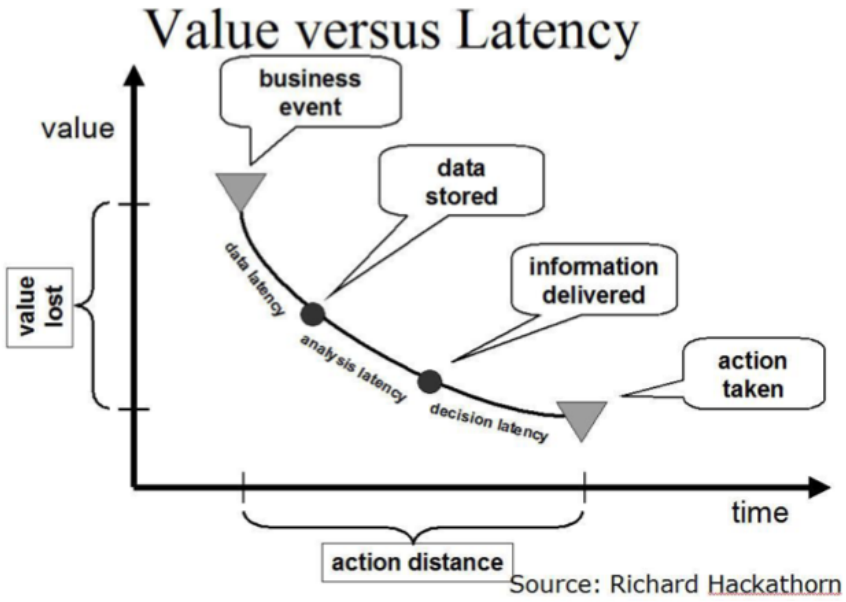

Figure 1: Business value vs latency (Hackathorn 2004)

Watson, Wixom, Hoffer, Anderson-Lehman and Reynolds (2006) note the business-driven purpose of RTBI is to increase revenues and decrease costs. Advances in RTBI applications have also helped to manage, automate and synchronize many of the business processes of customer relationship management (CRM) (Goldenberg 2008; Grigori *et al.* 2004). However, data will only need to be as fresh as its respective business requirements (Ioana 2008; Watson *et al.* 2006). Consequently the terms "right-time" or "near real-time" may be more appropriate than real-time (Pedersen, Castellanos, & Dayal 2014).

Implementing a RTBI system may require several additional components to a typical BI architecture (Acker, Gröne, Blockus, & Bange 2011; Hang & Fong 2010; Tank 2012) such as in-memory analytics and service-oriented architecture (SOA). Agrawal (2009) suggests that adoption of RTBI is hindered because of lack of clarity on technology requirements, and the substantial costs. Schneider (2006) stresses that benefits of business decisions made under low latency must outweigh the significant investment in achieving RTBI (Ward, Daniel & Peppard 2008), and Seufert and Schiefer (2005) list seven ways in which RTBI can generate value. Chan, Tan, Lau and Yeoh (2013) quote research that indicates that strong demand for mobile BI will increase incidence of real-time BI, because of the many applications that could benefit mobile workers (Andriole 2012). RTBI implementation is unlikely to be successful unless the organisation has reached a relatively high level of BI maturity (Rajterič 2010).

3. Research objective, questions and approach

The primary objective of this research is to produce a roadmap or framework which serves as a guideline for organizations planning on moving into the RTBI sphere. In order to achieve this objective four research questions were investigated:

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

Because of the lack of published information on local RTBI implementations, the study was exploratory, interpretive and inductive, aiming to uncover and understand the key issues involved (Klein & Myers 1999). A purposive sample of organisations with involvement in the RTBI area was therefore chosen. Seven senior business and IT management staff were interviewed from South African companies in financial services, retail, energy, transport and IT consulting. Respondents were given advance information of the types of questions that would be asked, and ethical requirements and confidentiality were observed. Semi-structured in-depth interviews of an hour or more enabled most important areas to be covered, while enabling an open flow of conversation, and for respondents to volunteer points on areas not conceived of beforehand. Interviews were recorded digitally and then fully transcribed. A process of thematic analysis (Braun & Clarke 2006; Thomas 2006) was used to code segments of text, create categories, and iteratively combine and summarise these into themes. Thomas (2006 p5) states the importance of finishing with "three to eight summary categories". The six themes that emerged were: technological considerations, organisational considerations, users, application areas and analytics, benefits, and the investment process. Each of these had a number of sub-themes.

4. Analysis of themes and sub-themes

The main emergent themes and their sub-themes are now discussed, with illustrative quotes.

4.1 Technological considerations

In this section, various fundamental technological elements of a RTBI system will be explored. Although it was found that BI architectures will vary depending on their context, their underlying technical structures share common components.

4.1.1 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. Integration is a key component in creating a technical landscape that supports RTBI.

> *"… 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"*

The high dispersal of systems around the organization also made integration more difficult. For many large organizations, such as retailers and banks, legacy systems were found to still support many business functions. Some expressed difficulty in integrating them because they are not really designed for real-time.

> *"…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"*

4.1.2 Message-bus or enterprise service bus (ESB)

The message-bus is a key component of a RTBI architecture as it provides the means to integrate an organization's systems and route their data into a repository. This addresses many of the challenges that come with the integration process, and includes integrating internal and external systems (including legacy systems) into one space in such a way that it does not impact business systems.

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

The implementation of a message-bus can be seen as one of the initial steps to configuring a RTBI architecture. The value of a message-bus comes not only from its ability to integrate systems, but because the real-time data flowing through it can be intercepted. While doing this, a host of analytics can be applied to it, but it also needs to be compared with historic data in order to contextualize it.

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

4.1.3 Data

All companies had large amounts or operational and transaction data, often using this for analytical purposes. The importance of a master data management environment was stressed.

> *"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"*

Some were looking at combining their transaction data with social network data, but noted problems in dealing with the less-structured data analytically.

The frequency with 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"*

The ETL process is one of the major reasons for latency. In order to achieve a real-time environment it was noted that ETL processes should not be used to fix incomplete data. Instead, using business rules, data should be validated at its source (host systems).

> *"You can't have these sophisticated ETL processes which are going to try and fix deficient information…your business rules should be on your systems and not on your ETL processes"*

4.1.4 Architecture

The points and technologies mentioned above indicate different architectural requirements, with the use of the message-bus and an operational data store (ODS) being key.

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

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, the ODS sits between the host systems and the DW and intercepts data flowing through the message-bus and then compares it in real-time against historic snapshots or target values from the DW.

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

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, and in-memory analytics was also being used, independently of the DW:

> *"…looking at solutions that are sitting on top of your transactional systems with in-memory capabilities."*

The need for on-going flexibility was also mentioned:

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

4.2 Organisational considerations

The following organisational issues were mentioned regularly during the interviews:

4.2.1 BI / DW maturity

Several organisations noted the importance of first evaluating their maturity in the BI and DW space. If not mature here, they were more likely to run into obstacles when attempting RTBI. Mature organisations were also likely to have more historic information in their DW, useful for analytics and comparing with real-time data.

4.2.2 Business process re-engineering (BPR) and change management

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 it's going to change a bit of our business processes"*

This may become a major task, and change management may be needed for two things: to facilitate business process reengineering and also to help individuals accept changes in their business environment. In one organisation this was needed when a policy holding users responsible for data quality was introduced.

> *"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"*

4.2.3 Skills and support

RTBI implementation will require the skills to put it in place and also to support it. In addition, it may require that IT staff become more knowledgeable of the business itself.

> *"The people implementing it also need to understand the business"*

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"*

4.2.4 Business rule definitions

As one respondent commented:

> *"... 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"*

This can be a challenging task because business rules are context-specific, and every organization needs to assess its own requirements and objectives first, e.g.

> *"... 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"*

4.2.5 Requirements and driving force

One of the organisational aspects mentioned most was the driving force behind going real-time – either addressing business problems, or harnessing opportunities. One organisation wanted to have real-time metrics on employee work satisfaction. Another wanted to take a proactive approach towards fraud. A retailer wanted real-time visibility at the point of sale (POS), and to integrate information silos in service level areas. In all cases these need to contribute to a business plan to justify the investment.

4.2.6 "Build or buy" and costs

Decisions whether to build or buy solutions featured strongly in the interviews. The general view, from organizations that are not in the software development industry, is that

> *"...we try and buy everything; it's just a lot less expensive for us"*

Some, however, had to tailor a solution by purchasing several components and integrating them.

> *"... 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"*

> *"... aren't vendors out there that have got to that level of sophistication"*

This will require the appropriate skills needed to then configure the solution.

> *"so [often] there is no one vendor that has everything"*

> *"Sometimes the solution becomes purchasing one or two items and plugging them together and coming up with a solution"*

Vendor research and assessment is an important part of this process. Notable factors included vendor maturity, skills, and availability of support.

> *"[do they have the] skills available to support it?"*

Apart from the build or buy decision, 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"*

This supports the need to identify feasible realization of measurable business benefits from real-time BI that can justify the costs involved.

4.3 Application areas and analytics

This summarises some areas in which RTBI and analytics were found to be applied.

4.3.1 Process intelligence

This proved to be a significant value-generating aspect. 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."*

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"*

Monitoring this real-time data on its own however, provides little insight. As mentioned earlier, it needs to be combined with historic or projected data, targets or indicators to put it in context.

Through business activity monitoring (BAM) users can make informed and timely decisions at the operational level, and subsequently help to improve tactical and strategic performance measures. In the airline industry for example:

> *"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."*

This includes key performance indicators (KPIs), which may be dynamic:

> *"You see it needs to be a dynamic KPI so that the threshold is … continuously updated based on your history. e.g.: refreshed each day based on the last 12 weeks"*

Dashboards are used extensively.

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

The detection of anomalies is highly advantageous because it provides organizations with actionable information in a timely manner, and can be applied in 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"*

Anomaly detection was applied for fraud detection at two organisations. 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"*

4.3.2 Predictive analytics

This predicts trends and future behaviour by deriving patterns from a mix of historic and live data. All organisations were using it to some extent in different applications such as sales and demand forecasting. Some related applications follow.

4.3.3 Fraud detection and forensics

Because fraud is a time sensitive issue, if it can be detected early enough, it can be prevented.

> *"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"*

RTBI only enables this kind of environment; finding the fraudulent transactions however, is based on learned business rules.

> *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"*

4.3.4 Dynamic pricing and yield management

These dynamic pricing decisions are often quite complex because they have to factor many variables to determine an optimum price. The airline industry respondent explained:

> *"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"*

A retailer also included 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". "… you can adjust them [price] in the store"*

4.3.5 Demand monitoring and forecasting

This uses mathematical techniques on historic data and real-time information from the supply chain.

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

> *"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"*

4.3.6 Supply chain improvement

The petroleum supplier's logistics management is a complex task. Many of these processes however, can be improved in a real-time environment.

> *"… 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 harbour in [Country A], what is our delay time, their harbour time, offloading, transporting …"*

4.3.7 Customer relationship management (CRM)

Although this was in use by all organisations in a general sense, they were still starting to explore its use in a real-time environment, and mentioned future possibilities rather than current applications.

4.4 Users

RTBI users at different levels of the organization are likely to have different information requirements as well as different data latency demands, and it is important to understand these. At strategic and tactical levels data latency required is generally similar to that of traditional BI. But operational managers and users need low latency transaction data, as for the financial forensic analysts:

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

User training was also needed as data was different to that of traditional BI, and to make 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"*

Change management may be required to overcome resistance and assist cultural change:

> *"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"*

RTBI offers users most value at the operational level, in terms of decision-making. 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"*

4.5 Benefits

Many of these have already been alluded to, and others will be briefly mentioned, such as visibility:

> *"… 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"*

With the new information available, learning and discovery has increased.

> *"… 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"*

Prediction has increased and the impact of different possible scenarios is being assessed.

> *"… reporting has also changed from being backward-facing to being a whole lot more forward-facing … saying what is going to happen"*

Similarly there has been a move from being reactive to proactive:

> *"At our operational level is where we have a need for real-time business intelligence…. For example we want to see if a flight is delayed so we can react immediately"*

There has also been an increase in adaptive, automated decisions in the operational systems, e.g.

> *"….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"*

4.6 Investment Process

This describes the steps necessary to justify and obtain approval and budget for a RTBI implementation. As a starting point it is vital to first identify measurable business problem(s) or opportunities which real-time BI can address. These form the crux of the business case and ultimately drive the proposal. In a situation like this, technical approval is also usually required.

> *"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"*

> *"… 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"*

Some organizations started off with smaller investments, with business cases which subsequently 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"*

4.6.1 Stakeholders

While a proposal is normally triggered by a business problem or opportunity and business stakeholders, IT departments were also found to contribute strongly to 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"*

> *"… we continuously try to innovate, it's one of the biggest things we try to do internally in IT" ……"… a combination of ideas from the business … and also the technology team; the software development team"*

Directors such as the CEO, CFO, CIO, and COO, are typically present for such a proposal. 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 also how technology can support the business's needs. There are however often communication difficulties between the two parties (IT and business).

> *"… 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"*

Some organizations were found to have established investment committees dedicated to reviewing and approving investment proposals.

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

Multiple stakeholder input is also particularly important when it comes to the decision to build or buy (see 4.2.6), and especially in justifying the technology. This decision does not only involve IT, but requires a strategic and financial assessment as well.

4.6.2 Trust

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"*

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.

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

One way in which they can gain trust is by being conservative in their ROI projections. 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"*

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

4.6.3 Quantifying Benefits

Identifying measurable benefits of the proposed RTBI system is one of the most crucial components for building a credible business case for the investment. Those that are measurable are quantified and used to calculate a ROI estimate, and an investment must first demonstrate that it is financially prudent. Some organizations also applied hurdle rates (a minimum acceptable rate of return) in their calculations.

> *"… 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"*

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 (Kaplan & Norton 2008) which extends benefits realization beyond financial dimensions. These kinds of benefits are difficult to measure, and there is often uncertainty as to how these should be used in a business case.

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

Some organizations did attempt to quantify these softer benefits by using estimations. For instance, a financial services company calculated their softer benefits based on "assumptions and history".

4.6.4 System Growth Planning and Scalability

The choice of technology and environment should be scalable and flexible to allow it to adapt to changing business needs. One organisation noted:

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

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. 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"*

5. Discussion and Summary

This summarises some of the issues that emerged from the analysis, and later leads to development of a roadmap for RTBI justification and implementation planning.

The Technological theme (See Table 1) revealed a few key aspects for RTBI. Integration of systems assumed an even greater role, with unsuitability of some legacy systems being noted. Apart from the increased velocity of the BI data, variety that included unstructured and social media data would add to the difficulties of management and metadata. In order to achieve RTBI, a new flexible architecture was needed, which could accommodate concepts of BAM, an ODS and the important message-bus.

Table 1: Summary of technological considerations

Theme	Issue(s)
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

As with any BI implementation, Organisational issues proved highly significant (See Table 2). Up front, detailed requirements had to drive a sound business case that would justify the investment. Sensible decisions on build versus buy were needed. BPR with clearly defined business rules and change management would probably be required, as would a new set of skills for both IT and users.

Table 2: Summary of organisational 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; justification; maturity
	Buy : configuration; vendor assessment
Change Management	BPR management
	User resistance

A varied range of RTBI applications was mentioned (See Table 3), with process intelligence generating many analytics applications and capabilities.

Table 3: Summary of application areas and related analytics

Application Area	Analytics
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	

Differences in requirements of users at different organizational levels were assessed in terms of objectives, types of users, and data latency requirements. At strategic and tactical levels, information requirements were found to be typical of traditional BI. The former focus on long-term objectives (strategic goals), and analysis is on data with a high temporal window, such as weeks or even months, mainly historic data. The latter focus on tactical objectives and users typically include financial analysts, and business managers; here the data latency is normally within weeks or days.

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. Furthermore, requirements vary not only across organizational levels, but across different types of users. 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. With real-time BI, decision-making is also becoming increasingly automated, especially at the operational level where common and repetitive decisions are frequent. Decision-making is now more embedded into the normal business workflow whereby systems are able to automatically sense conditions or identify problems. The deployment of a real-time BI system will therefore impact users in a variety of ways, and this change will need to be managed so as to avoid potential resistance to the system, and more training is required. (See Table 4).

Table 4: Summary of user-related aspects

Theme	Outcome
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

According to those interviewed, RTBI provided a solid list of benefits, as shown in Table 5.

Table 5: Summary of real-time BI benefits

Theme	Outcome
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

Many of these could be classed as intangible, but they increased organisational ability to improve profit and decision making and reduce risk in various ways. The main impact of these benefits on the business user was at the operational level, requiring in many ways a different mind-set, training and change management.

6. A suggested roadmap for planning RBTI

The information that was gathered through answering the four research questions was also used to suggest a roadmap that aims to assist organizations in producing meaningful and insightful justification for real-time BI. The conceptual model in Figure 2 (A roadmap for RTBI justification and implementation planning) aims to provide an answer to the primary research objective:

> *"…to produce a roadmap or framework which serves as a guideline for organizations planning on moving into the RTBI sphere."*

The purpose of the roadmap would be to inform and equip organizations with the necessary information they should know before pursuing such an investment.

A few points are now made about each of the seven phases (Business Analysis to Approval and Post Approval).

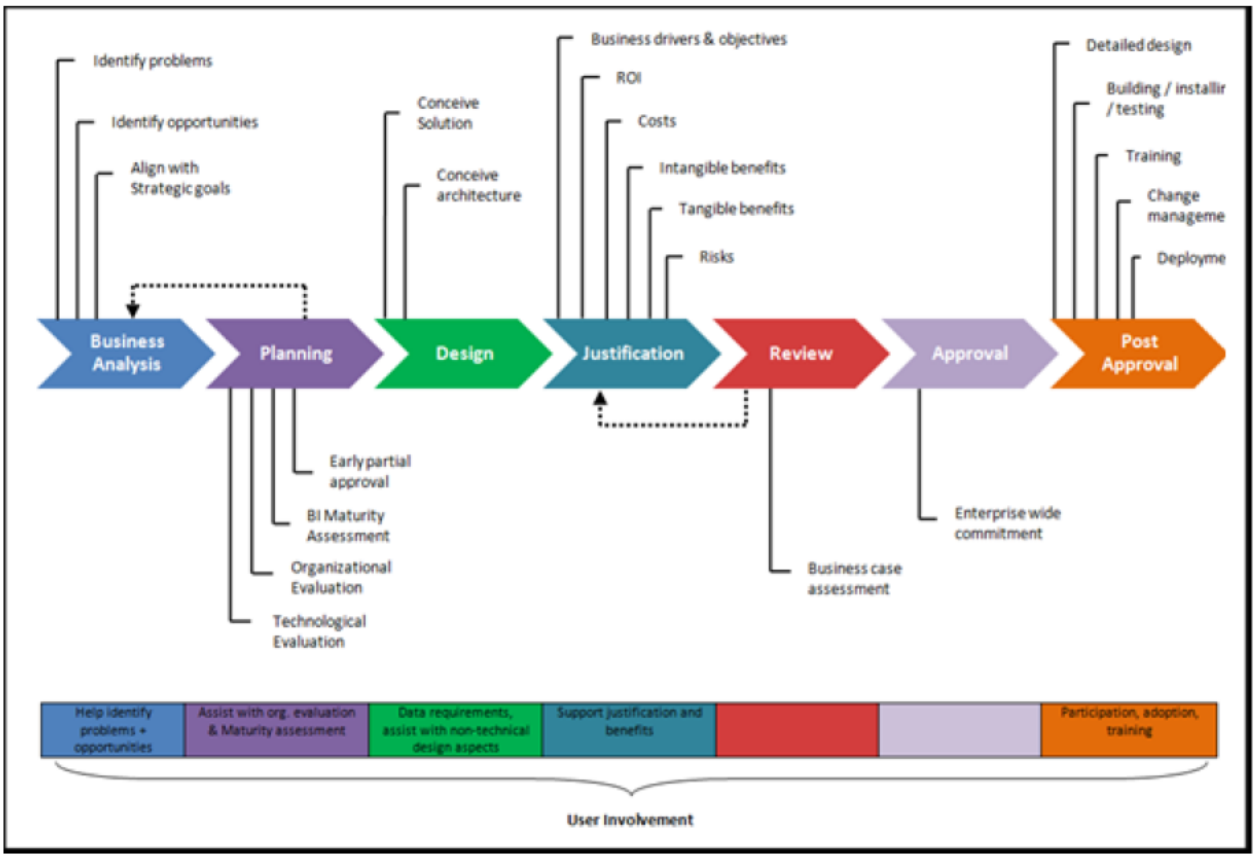

Figure 2: A roadmap for RTBI justification and implementation planning

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.

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.

A proposal may require partial approval in this phase; so it is important that the business analysis has been conducted in detail, the status quo has been evaluated, and requirements for achieving the desired real-time environment have been understood. 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. If there are concerns regarding the proposal at this stage, organizations may need to return to the Business Analysis phase (illustrated by the dotted line in Figure 2).

Design: The Design phase is primarily centred on conceiving solutions for the identified business problem / opportunity, and for the required architecture. For the former, a build or buy analysis may need to be conducted. If, however, the solution is being developed in house, further financial analysis, such as cost-benefit analysis, should be carried out, as well as an assessment of the existing level of internal IT skills and support.

The research found that a suitable 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.

Justification: At this stage of the process 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 of putting the solution in place.

It is critical for practitioners to understand that the justification should be business-driven and not IT-driven.
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 for financial and organisational viability. Practitioners, however, also need to 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 in Figure 2).

Approval and Post Approval: After successful buy-in has been achieved, including both business and technical approval, several issues still lie ahead. While these are out of the scope of this research, they will briefly be mentioned. First, it is likely that a more detailed and specific design plan will need to be put together. The building / installing and testing phase is expected to be a major task for IT, and will therefore require additional planning, management and coordination. Preparation for implementation may require training and change management practices, particularly at lower levels where users are not accustomed to using analytical environments for decision-making. Deployment of the system will also require significant planning, and it is advised that a staged approach be adopted where possible. 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.

7. Conclusion

The research aimed to uncover and understand the key issues involved in RTBI implementation, using a purposive sample of South African companies in different industries. Results clearly cannot be generalised to all companies, South African or otherwise, but hopefully create a greater understanding of many of the factors that should be borne in mind when embarking on RTBI. As with the currently much-hyped theme of big data analytics, careful attention should be paid to the real benefits that might be achievable with RTBI, in relation to the current BI maturity of the organisation, and the costs involved. Companies should also consider carefully whether "near real-time" or "right-time" is appropriate for them and their business environment.
Taking cognisance of these key issues, a roadmap for RTBI justification and implementation planning was also proposed, and it is hoped that this will give a holistic picture of the process that could be followed in creating an appropriate justification for RTBI, and for planning its successful implementation.

Further research could be carried out to examine how the availability of RTBI has impacted on the decision processes of a wider set of organisations. It could also look specifically at organisations that are seriously attempting to apply RTBI to the "big data" situation of expanded velocity, volume and variety, using machine-generated and unstructured and semi-structured data as well as structured data.

Acknowledgements

This work is based on research partly supported by the National Research Foundation. Any opinion, finding or conclusion or recommendation expressed in this material is that of the authors, and the NRF does not accept any liability in this regard.

References

Acker, O., Gröne, F., Blockus, A. and Bange, C. (2011) "In-memory analytics–strategies for real-time CRM", *Journal of Database Marketing & Customer Strategy Management*, 18(2), 129-136.

Agrawal, D. (2009) "The Reality of Real-time Business Intelligence" [PowerPoint slides]. Retrieved from http://birte08.stanford.edu/ppts/08-agrawal.pdf [Accessed April 2010]

Andriole, S. J. (2012) "Seven Indisputable Technology Trends That Will Define 2015," *Communications of the Association for Information Systems*, 30(4). Retrieved from: http://aisel.aisnet.org/cais/vol30/iss1/4

Azvine, B., Cui, Z. and Nauck, D.D. (2005) "Towards real-time business intelligence", *BT Technology Journal*, 23(3), 214-225.

Braun, V. and Clarke, V. (2006) "Using thematic analysis in psychology", *Qualitative Research in Psychology*, 3, 77-101.

Chan, L-K., Tan, H-K., Lau, P-Y., and Yeoh, W. (2013) "State-of-the-art review and critical success factors for mobile business intelligence", *Communications of the IBIMA*, Article ID 246123, 1-10.

Derksen, B. and Luftman, J. (2014) "European Key IT and Management Issues & Trends for 2014", CIONET Europe.

Eckerson, W.W. (2004) "The "soft side" of real-time BI", *DM Review*, 14(8), 30-67.

Goldenberg, B.J. (2008) *CRM in Real Time - Empowering Customer Relationships*. Medford, New Jersey: Information Today, Inc.

Grigori, D., Casati, F., Castellanos, M., Dayal, U., Sayal, M. and Shan, M.C. (2004) "Business Process Intelligence", *Computers in Industry*, 53(3), 321-343.

Hackathorn, R. (2004) "The BI Watch: Real-Time to Real Value", *DM Review*, 14(1), 24-43.

Hang, Y. and Fong, S. (2010) "Real-time Business Intelligence System Architecture with Stream Mining", Paper presented at the 5th International Conference on Digital Information Management (ICDIM), Thunder Bay, Canada.

Ioana, D. (2008) "Operational and Real-time Business Intelligence", Informatica Economică, 3(47), 33-36.

Kaplan, R. S., and Norton, D. P. (2008) "Using the Balanced Scorecard as a Strategic Management System", *Harvard Business Review*, July-August 2007, 150-161.

Kappelman, L., McLean, E., Johnson, V., and Gerhart, N. (2014) "The 2014 SIM IT Key Issues and Trends Study", *MIS Quarterly Executive*, December 2014 (13:4), 237-263

Klein, H.K. and Myers, M.D. (1999) "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly*, 23(1), 67-93.

Korotina, A., Mueller, O.; and Debortoli, S. (2015) "Real-time Business Process Intelligence. Comparison of different architectural approaches using the example of the order-to-cash process", *Wirtschaftsinformatik Proceedings* 2015, Paper 114. Retrieved from http://aisel.aisnet.org/wi2015/114

Pedersen, T.B., Castellanos, M., and Dayal, U. (2014) "Report on the Seventh International Workshop on Business Intelligence for the Real Time Enterprise (BIRTE 2013)", SIGMOD Record, December 2014, 43(4), 55-58.

Rajterič, H.I. (2010) "Overview of Business Intelligence Maturity Models", *International Journal of Human Science,* 15(1), 47-67.

Sahay, B.S. and Ranjan, J. (2008) "Real time business intelligence in supply chain analytics", *Information Management Computer Security*, 16(1), 28-47.

Schneider, D. A. (2006). "Practical Considerations for Real-Time Business Intelligence", In BIRTE Workshop, *Business Intelligence for the Real-Time Enterprises* (1-3). Seoul, Korea: Springer.

Seufert, A. and Schiefer, J. (2005) "Enhanced Business Intelligence – Supporting Business Processes with Real-Time Business Analytics", In Proceedings of the 16th International Workshop on Database and Expert Systems Applications, (919-925). Copenhagen, Denmark.

Tank, D.M. (2012) "Reducing ETL Load Times by a New Data Integration Approach for Real-time Business Intelligence", *IJEIR*, 1(2), 1-5.

Tank, D.M. (2015) "Enable Better and Timelier Decision-Making Using Real-Time Business Intelligence System", *I.J. Information Engineering and Electronic Business*, 1, 43-48.

Thomas, D.R. (2006) "A general inductive approach for analyzing qualitative evaluation data", *The American Journal of Evaluation*, 27(2), 237.

Villars, R.L., Olofson, C.W. and Eastwood, M. (2011) "Big Data: What It Is and Why You Should Care", *IDC* #228827, June 2011, 1-14

Ward, J., Daniel, E. and Peppard, J. (2008) "Building better business cases for IT investments", *MIS Quarterly Executive*, 7(1), 1-15.

Watson, H. J., Wixom, B. H., Hoffer, J. A., Anderson-Lehman, R. and Reynolds, A. M. (2006) "Real-time Business Intelligence: Best Practices at Continental Airlines", *Information Systems Management*, 23(1), 1-16.