

A Framework for Understanding the Critical Success Factors of Enterprise Business Intelligence Implementation

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ABSTRACT

Implementation of a business intelligence (BI) system requires considerable resources. Although, the BI market appears vibrant and the importance of BI is widely accepted, few studies have investigated the Critical Success Factors (CSF) that affects its successful implementation. There is an imperative for a CSF approach to enable BI stakeholders to focus on the key issues that lead to successful BI systems implementation. This paper investigates the success factors and their contextual issues that may help organizations achieve a successful BI system implementation.

Keywords

Business intelligence, BI, BI implementation, CSF, critical success factors.

INTRODUCTION

Enterprise business intelligence is one of the most important keys to be able to outstand in today's economy. However, success no longer means accumulating the most important information, but rather knowing how to effectively use and manage this information. The business intelligence (BI) market has been continuously experiencing growth as vendors keep on reporting substantial profits (Chen et al. 2012). In a survey of 1400 CIOs, BI featured in the list of top ten priorities (Gartner 2009). Despite tremendous interest in BI, there are still a very small number of published papers pertaining to people, business and IT related BI issues (Jagielska et al. 2000). Therefore, an understanding of the CSFs enables BI stakeholders to optimize their scarce resources and efforts by focusing on the significant factors that are most likely to aid successful implementation. This paper aims to present an insight into BI and the CSFs that can help in overcoming technological gaps as well as the challenges surrounding its implementation.

RESEARCH STUDY OBJECTIVES

This study describes an exploration of an important topic of interest and it can be valuable to researchers and practitioners who are studying, providing consultancy services, planning or implementing BI systems. From a practical standpoint, the findings of this study help BI project stakeholders to both identify and concentrate on the CSFs, especially in the planning of BI systems. For them, this study will provide an insight on the CSFs factors deemed as most important for the successful implementation of business and show how closely interrelated they are with the set of critical success factors framework developed in the next chapter. In theoretical and practical terms, this research:

- Contributes to the literature of an emerging topic of interest that is the implementation of BI systems -- more specifically, the success factors that affect the implementation effort.
- Investigates the challenges and criteria, which define the success of BI systems.
- Studies previous literature in which CSFs influence the implementation on BI systems.
- Develops a CSFs framework that can be used by BI practitioners in better using their scarce resources by focussing on those areas, which need more attention.

According to Kulik (1997) the importance of understanding why projects succeed is – “repeating what worked on successful projects is a powerful strategy to ensure the success of future projects”.

Key Components of BI

BI tools are widely accepted as a middleware between transactional applications and decision support applications, thereby decoupling systems tailored to an efficient handling of business transactions from systems tailored to an efficient support of business decisions (Ranjan 2008; [1]. However, as agreed by several authors, implementing a BI system is not a simple activity entailing simply the acquisition of a combination of software and hardware; but rather a complex undertaking requiring the proper infrastructure and resources over a lengthy period (Watson et al 2004; Moss and Atre 2003; Fuchs 2006).

A BI system is composed of a set of three complementary data management technologies, namely online analytical processing (OLAP), knowledge discovery which is predominantly aided by data mining techniques and data warehouse (Fisher et al. 2006). Ranjan (2008) and Azvine et al. (2005) amongst others strongly agree that consolidating data from the many different enterprise operational systems into an enterprise data warehouse is one of the main keys to a successful BI system. The data warehouse supports the physical propagation of data by managing the numerous enterprise records for integration, cleansing, aggregation and query tasks. Further, Olszak and Ziemba (2007) also state that a data warehouse provides some room for thematic storing of aggregated and analyzed data. More importantly, it is vital to note that several researchers (Ballard et al. 2006; Olszak and Ziemba 2007; Turban et al. 2007; Fisher et al. 2006; Negash and Gray 2006) recognize the importance of data warehouse as the infrastructure backbone to support several analytical processing and visualization applications.

Benefits of BI

The benefits of BI range from minimising risk to making smarter decisions, to saving time and money, to getting a jump on competition (Sharp 2004). BI can eliminate a lot of guesswork within an organization, enhancing communication among departments while coordinating activities and enabling companies to respond quickly to changes in financial conditions, customer preferences and supply chain operations (Ranjan 2008; Atre 2008; Watson and Wixom 2007).

Many authors are in agreement that BI saves time for the data supplier and users because of more efficient data delivery. As such, it creates better and more focused marketing as well as enhanced relationships with customers and suppliers (Ranjan 2008; Atre 2008; Watson and Wixom 2007).

According to Ranjan (2008), firms have recognised the importance of business intelligence and that it has arrived for the masses. Some of them are listed below:

- With business intelligence, organizations can track their most profitable customers and the underlying reasons for those customers' loyalty.
- Employees can now easily convert their business knowledge via the analytical tools to solve many business issues.
- Analyse potential growth customer profitability. Determine what combination of products and service lines customers are likely to purchase and when.

Building on the survey of 510 corporations, Eckerson (2003) reported that the major benefits of business intelligence as viewed by participants were: time savings, a single version of truth, improved strategies and plans, improved tactical decisions, more efficient processes and cost savings. Likewise, Thompson (2004) identified the following benefits from a survey he conducted; faster and more accurate reporting; improved decision making; improved customer service and increased revenue.

Ranjan (2008) and Watson (2007) are both of the opinion that in order to be successful firms must stay one level ahead of the competitors. Business intelligence indicates what actions our competitors are taking so that one can make better informed decisions.

Challenges Faced in BI

Increasingly organizations are realizing that there is more to BI than simply employing technology. Business intelligence requires many technologies, tools and needs to interoperate with many enterprise applications and systems. More to the point, there is a need for a comprehensive, strategic approach to BI that addresses human capital, knowledge processes and culture. There are many challenges to make them work together seamlessly.

Several authors claim that the data required and time and effort necessary to acquire the necessary data to ensure their accuracy is often underestimated (Miller et al. 2006; Azvine, Cui et al. 2005). This often results in user requirements not

sufficiently met and thus the analysis is repeated with different parameters. Data issues are typically the leading cause of failure and the most costly element of BI implementations.

Both Atre (2008) and Cui et al. (2005) state that it usually takes a lot of time, resources and effort to identify, map and create necessary rules and processes to ensure that the data are used consistently and accurately across the organization, promoting a single version of the truth. Resolving data quality issues requires communication and working together with various groups and experts to resolve the root causes and underlying issues. Where BI is concerned, collaboration is not only restricted to departments within an organization, it requires integration of knowledge about customers, competition, market conditions, vendors, partners, products and employees at all level. Thus, it is very important to highlight that several authors have stressed on the importance of nurturing a cross organizational collaborative culture in which everyone grasps and works towards the strategic vision (Miller, Brautigam et al. 2006; Azvine, Cui et al. 2005; Atre 2008).

Building on a research that was carried out by Microsoft, it has been found that due to the complex nature of IT projects, BI deployment timelines frequently far exceed initial expectations, often taking many months and in some cases, years to implement. As a result, longer implementations require more resources allocated and increased pressure on project budgets, not to mention the challenge of assessing the deployment's return on investment (ROI).

RESEARCH METHODOLOGY

This study identifies the gaps by building the theory of the ways in which CSFs impact BI systems implementation and explores and identifies a set of CSFs that are jointly agreed by a group of BI system experts.

Therefore, a research framework for understanding CSFs from existing literature was developed and based on the framework, a set of multi-dimensional CSFs was identified during the course of the interviews with 16 BI consultants who possess substantial experience in the field. The interpretivist paradigm and the mixed methods approach whereby online and face to face interviews were used, helped in determining the fundamental relationships between critical success factors of the organizations, and framework of defined CSFs, by comparing how closely related they are and what the companies regard as most crucial.

Statistical consensus has been sought among the participants through the interview survey using PASW Statistics 18. Since the data was derived from a relatively small sample and our research largely exploratory, we avoided regression analysis. The interviews consisted of both open and close-ended questions.

ANALYSIS OF CRITICAL SUCCESS FACTORS

Poon and Wager (2001), using a multiple case study method recognized ten CSFs that successful executive support projects mostly achieve and these are: a committed and informed executive sponsor, an operating sponsor, appropriate IS staff, appropriate technology, management of data, a clear link with business objectives, an evolutionary development methodology, clearly defined requirements, management of organizational resistance, and management of system evolution and spread.

Further to the point, Wixom and Watson (2001) also conducted a survey based on the factors affecting BI success and they categorized them into 3 main areas namely: organizational, project and technical implementation success. More specifically, they identified the micro factors of management support, championship, resources, user participation, team skills, source systems and development technology. It is important to point out that their concept of management support is a replacement factor for the single operational sponsor of Poon and Wager CSF set. It can thus be said that widespread management support is required to drive the organizational change that accompanies the BI project.

Based on studies carried out by Yeoh and Koronios (2010), the CSFs that should be considered for implementation of BI systems are: commitment management and support, clear vision to well-established goals, business centric championship and balanced team composition, business driven and interactive development approach, user oriented change management as well as sustainable data quality and integrity. Sammon and Finnegan (2000) explored the organizational prerequisites for the implementation of a BI project and based on four case studies they found out about the following fundamentals: a business driven data warehousing initiative, executive sponsorship and commitment, funding commitment, project team skills, source data quality, a flexible enterprise data model, data stewardship, a long term plan for automated ETL, knowledge of data warehouse compatibility with existing systems and hardware/software proof of concept.

Likewise, a study conducted by Howson (2006), revealed that the factors to be taken into account for a successful BI implementation are: developing a strategy, managing the program well, ensuring executive support, choosing the appropriate tools, standardizing on a platform and aligning BI strategy with business. Howson (2006) believes that the BI process demands a broader skill set and business focus than other aspects of IT since there is comparatively little challenge, which is

about technology. Indeed these views are supported by Gartner Research (Burton and Geishecker 2006), who stated that ‘best in class organizations focus on business objectives and use a business-driven approach to define and scope their people, process, application, technology and/or services strategy’.

However, while several studies described above have supported the concept of CSFs for BI implementation, other researchers have raised concerns about the approach. Nandhakumar (1996) examined the deep structure of BI implementation in terms of CSFs and in addition to confirming the importance of CSFs; he found that there are important interrelationships between the factors. To this end he laid emphasis on the fact that CSFs were not constant in their influence and importance during the life of the project.

Quite along the same line, Bussen and Myers (1997) also criticized the factor approach to understanding the BI success and failure, stating that a satisfying static CSF set is not sufficient explanation for system outcomes. After studying a BI failure case in the manufacturing and distribution company, they found that an analysis of the historical, political, social and economic contexts of the case had equal, if not greater impact on the system failure than the CSFs set. This fact is also supported by Wixom and Watson (2001) who in a survey based study found out that factors other than their variant of BI affected data quality and success. Additionally, McBride (1997) supported the view that success factors are dynamic and influenced by organizational context, there are a number of macro and micro contingent variables that affected success in a BI company.

Despite the concerns addressed by the authors above, CSF definitely remains a useful construct for understanding what goes right and what goes wrong in a BI project. Arnott (2008) is of the opinion that executives, managers and IT specialists readily understand the CSFs professionals and can be an effective construct for moving theory into practice.

The analysis of the critical success factors discussed above form the basis for a new framework for implementation of BI systems and we describe them in the following sections.

FRAMEWORK FOR CRITICAL SUCCESS FACTORS

As discussed before, setting a framework for those factors that are critical to the success of a BI implementation in an organization is the first step. Table 1 lists and describes these ten factors along with references to articles where they are quoted and discussed.

Critical Success Factors	Brief Description	References
1. Committed Management Support	BI should be business driven with widespread management support. The commitment and involvement of senior management is imperative since this will help in overcoming resistance and manage the change process.	Arnott (2008) Howson (2006) McBride (1997) Poon and Wagner (2001) Sammon and Finnegan (2000) Watson et al. (2004) Wixom and Watson (2001) Yeoh and Koronios (2010)
2. Appropriate Team skills	Staff in the client organization and external suppliers should have the appropriate knowledge, skills and experience.	Adelman (2005) Poon and Wagner (2001) Sammon and Finnegan (2000) Wixom and Watson (2001) Yeoh and Koronios (2010)
3. Flexible and appropriate technological framework	There should be a high degree of organizational fit with the BI hardware and software and the system should be able to adapt to the emerging and ever-changing business requirements.	Poon and Wagner (2001) Olszak and Ziembra (2007) Howson (2006) Sammon and Finnegan (2000) Wixom and Watson (2001) Knox (2002), Moss & Atre

4. Align BI strategy with business objectives	The BI implementation should have a clear link with the business strategies and be economically justified in terms of the business value it is providing.	Arnott (2008) Howson (2006) Poon and Wagner (2001) Rainer and Watson (1995) Watson et al. (2004) Yeoh and Koronios (2010)
5. Clear vision and well-defined information and systems requirements	The project must be aligned to the strategic vision and it should therefore have an accepted definition of what is required from the system.	Rainer and Watson (1995) Poon and Wagner (2001) Watson et al. (2004) Yeoh and Koronios (2010)
6. User-oriented change management	The BI system should be developed iteratively with strong user involvement, evolving towards an effective application set.	Howson (2006) McBride (1997) Poon and Wagner (2001) Sammon and Finnegan (2000) Wixom and Watson (2001) Yeoh and Koronios (2010)
7. Effective data management	The data model should be flexible and extensible. ETL applications should ensure consistency and accuracy. Corporate data can only be fully integrated and exploited for greater business value once their quality and integrity are assured.	Howson (2006) Poon and Wagner (2001) Rainer and Watson (1995) Sammon and Finnegan (2000) Watson et al. (2004) Wixom and Watson (2001) Yeoh and Koronios (2010)
8. Committed and informed executive sponsor	A senior executive should be responsible for overall guidance of the project, allocating resources and representing the project to the executive team and board.	McBride (1997) Poon and Wagner (2001) Sammon and Finnegan (2000) Watson et al. (2004) Wixom and Watson (2001)
9. Project scope management	It should be clearly defined that the scope of a project can increase significantly and this can stretch project resources.	Lindsey and Frolick (2003) Rainer and Watson (1995) Reinschmidt and Francoise (2000)
10. Adequate resources	There should be adequate funding of hardware, software and human resources.	Lindsey and Frolick (2003) Sammon and Finnegan (2000) Wixom and Watson (2001)

Table 1. CSFs and their descriptions

This study identifies the gaps by building the theory of the ways in which CSFs impact BI systems implementation and explores and identifies a set of CSFs that are jointly agreed by a group of BI system experts. To further investigate upon the BI CSFs, additional case studies are needed to understand the forces that drive the factors and investigate on the appropriateness of those success factors in different organizations. As such, to assess the importance of the ten identified CSFs, further findings from BI practitioners will be investigated.

THE SAMPLE

For the selection of a sample of BI practitioners an exhaustive effort was made to identify those with extensive experience in implementing BI systems. Hundred and one individuals were identified as being ideal for the scope of this study. Internet searches also reinforced the search by listing those international companies, which operate in the business intelligence field. Professional networks such as LinkedIn was also used as a method to filter those individuals working in the BI field. However, when faced with barriers like shortage of time and distance, the interviewees were requested to fill out the questionnaire in their own time and email it back.

Initial emails were followed up a week later by emails and telephone calls(s). While conducting the interviews, focus was primarily was on managers, team leaders and consultants. According to Holme and Solvang (1991), selecting respondents with the right knowledge about the research area is crucial for any research. Subsequently, 16 BI practitioners agreed to participate in this study.

FINDINGS

The research framework, which was developed in Section 5, was based on the literature, with most of it mainly based on assumptions from business intelligence and data warehousing literature. However, the question that arises -*How valid is that framework when viewed from the perspective of BI practitioners who are mainly involved in providing implementation consulting services?*

The findings from the quantitative part of the interview attempted to answer this question. Additionally, the participants provided in-depth details and justification. Hence, the framework helped considerably in identifying appropriate factors and assisted in the categorization of the contextual elements of the Critical Success Factors. Table 2 provides the average ratings for the respective factors, from the framework, ranked by the mean. As the rating of a factor considered important is assigned a higher value (4 or 5) by the respondents, it is observed that the higher the mean of that factor greater is the level of importance attributed to it. Thus, we observe that the top 3 factors are all considered to be either important to very important.

It can be seen from the table that committed management support, committed and informed executive sponsor, clear vision and well defined system requirements, user oriented change management, alignment of BI strategy with business objectives, appropriate team skills, adequate resources and project scope management have a mean greater than 3.5 and thus are considered as being closer to important and very important. On the other hand, flexible and appropriate technological had a mean of 3.15 and was closer to being neutral as a factor. To this end, this factor is seen to be the least important from the framework.

Descriptive Statistics					
	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>SD</i>
f1 Committed management support	16	3	5	4.63	.619
f8 Committed and informed executive sponsor	16	2	5	4.25	.931
f5 Clean vision & well defined system requirements	16	2	5	4.19	.834
f6 User-oriented change management	16	2	5	4.00	.966
f4 Align BI strategy with business objectives	16	3	5	4.00	.894
f7 Effective data management	16	3	5	3.81	.911
f2 Appropriate team skills	16	2	5	3.62	.806
f10 Adequate resources	16	2	5	3.50	.816
f9 Project scope management	16	1	5	3.50	.894
f3 Flexible & appropriate technological framework	16	2	5	3.13	.806
Valid N (listwise)	16				

Table 2. Ratings of CSFs by practitioners

It has been observed from the data collected that, the positions of the BI practitioners can be broken down into three main categories namely - Consultants, Team Leaders and Managers. It would, therefore, be interesting to find out if there are any differences in the way these three categories rated the critical success factors. For example, have the managers rated the success factors differently as opposed to consultants or team leaders? To test for a statistically significant difference in the ratings based on the positions of the BI practitioners, the non-parametric Kruskal-Wallis test was applied.

Given that all *P* values are greater than 0.05 (Table 3), we therefore, accept the null hypothesis for the Kruskal-Wallis test. The results of the Kruskal-Wallis test showed that all the three positions have rated all the ten critical success factors approximately in the same way.

	Chi-Square	DF	P
f1 Committed management support	.982	2	.612
f2 Appropriate team skills	.635	2	.728
f3 Flexible & appropriate technological framework	1.071	2	.585
f4 Align BI strategy with business objectives	.804	2	.669
f5 Clean vision & well defined system requirements	.550	2	.760
f6 User-oriented change management	3.376	2	.185
f7 Effective data management	2.251	2	.324
f8 Committed and informed executive sponsor	2.747	2	.253
f9 Project scope management	.168	2	.919
f10 Adequate resources	.083	2	.959

Table 3. Kruskal-Wallis test results

The experiences reported from the interviewees clearly supported the multi-dimensional CSFs identified in the critical literature review, although, with some adjustments of a few contextual elements.

Based on the findings and discussion of the CSFs above, Table 4 summarizes the CSFs and associated revised contextual elements amended by the findings of the interviewees. Furthermore, the interviews also helped in explaining the nature and causes of the new CSFs identified.

Critical Success Factors	Contextual Factors
1. Committed Management Support	<ul style="list-style-type: none"> - Involvement of senior management to overcome resistance and manage the change process - Securing necessary operating resources - Assemble cross-functional and inter departmental functions.
2. Appropriate Team skills	<ul style="list-style-type: none"> - Combination of both interpersonal and technical skills - Presence of a Champion to manage organizational challenges - An appropriate mix of business expertise is essential - Appropriate knowledge, skills and experience
3. Appropriate resources and technological framework	<ul style="list-style-type: none"> - Stable and reliable back end systems - Extensible technical infrastructure - Adequate funding of hardware, software and human capital - Allocation of needed people, time and finance - High degree of organizational fit with the BI hardware and software
4. Align BI strategy with business objectives	<ul style="list-style-type: none"> - BI project should have a clear link with the business strategies - Economically justified in terms of the business it provides
5. Clear vision and well-defined information and systems requirements	<ul style="list-style-type: none"> - Project alignment to the strategic vision - Accepted definition of what is required from the system - Meet expectations of the users
6. User-oriented change management	<ul style="list-style-type: none"> - Developed iteratively with strong user involvement - Appropriate spending on training, support and change management

	<ul style="list-style-type: none"> - Manage user's expectations
7. Effective data management	<ul style="list-style-type: none"> - Flexible and extensible data model - ETL applications should ensure consistency and accuracy - Integration of data from multiple sources - Good data quality at source systems - Data security measures reinforced - Data governance
8. Committed and informed executive sponsor	<ul style="list-style-type: none"> - Responsible for overall guidance of the project - Allocation of resources and representing the project to the executive team and board - Removal of any political roadblocks - Documented business case which governs implementation - Authority over appropriate resources
9. Project scope management	<ul style="list-style-type: none"> - Clear definition that the scope of a project can increase significantly - Setting realistic objectives - Incremental delivery of system - Having a formal scope document

Table 4. CSFs and revised contextual elements

CONCLUSION

Building on the findings, it was noted that the relevance and importance of the different factors vary according to the phase of the implementation. It was noted that some particular factors are most important when the project gets started (e.g. management support, defining scope, committed and informed executive business sponsor), while some other factors become vital in the following stages of the project (e.g. user oriented change management, adequate resources).

Business intelligence solution is not a software package but rather a costly resource-intensive and complex undertaking (Moss and Atre 2003; Moss and Hoberman 2004; Olszak and Ziemba 2007). Therefore, many BI implementation factors must be carefully assessed before the real implementation is actualized. Understanding critical success factors is very important for the implementation of a business intelligence system. This thesis studied the CSFs and their associated contextual elements, which impacts BI systems implementation. First, based upon the literature review, a unified model presenting 10 critical success factors was presented. The findings from the 16 interviews were then examined and evidence from these studies clearly confirmed the construct and applicability of the CSFs framework, albeit with some slight adjustments to a few CSFs and contextual factors.

Furthermore, an investigation of the findings further demonstrates that organizational and project related factors are far more important and influential than technological factors. The first two ranked factors are committed management support and committed and informed executive sponsor. This suggests that organizations are in a far better position to address those CSFs through a business orientation approach.

This study not only highlights those factors that need to be addressed but also points out those, which are not so critical. Furthermore, the contextual elements of each CSF and the unified CSF framework provide a significant contribution as to how implementation of BI systems could be improved. Last but not the least, the findings of this research indicates that BI practitioners should not only consider technical issues but should also take account of project and organizational dimensions.

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