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Business Intelligence (BI) Critical Success Factors

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Abstract
Companies are increasingly focussing their information systems efforts around Business Intelligence (BI) solutions. The benefits realised from BI vary significantly from company to company. BI systems are now being used as extensions of Enterprise Resource Planning (ERP) systems as they consolidate, transform and analyse the vast amounts of data generated by the firm. Much attention has been given to the identification of critical success factors (CSF) associated with the adoption of ERP systems. However, there is only limited research that has focussed on the CSF associated with BI implementations as part of an ERP system environment. Hence, this research documents BI specific critical success factors that industry partners, venders or systems users have identified in their presentations at conferences, education forms or formal user group meetings.

Keywords
Business Intelligence, ERP systems, Critical Success Factors, BI, CSF.

INTRODUCTION
Throughout history companies have developed and implemented systems to facilitate the collection, processing and dissemination of information. The introduction of computer based technology to support these information systems has caused a revolution in information processing that has pervaded all levels and aspects of business. Indeed, companies have increasingly identified the importance of information technology (IT) in the achievement of strategic objectives (Scott Morton, 1991). Accordingly, individual departments developed or purchased functionally specific IT applications to support their decision making processes in accordance with strategic direction and goals. Increasingly every function of a company has utilised IT, from operational activities through to long-term strategic planning. It is estimated that by the turn of the last century that American companies were dedicating nearly 50% of their capital expenditure on IT (Carr, 2003). Peter Drucker (1998) believed that much of this IT was being used to produce data rather than information— information that could potentially have facilitated more effective decision making by management.

The role of information systems (IS) in supporting core business processes and transactions has seen the growth in both the number and variety of implemented applications. A major issue for many companies was the integration of data and processes from these heterogonous systems (Deliotte, 1999). This lack of integration resulted in poor data quality, inconsistent data definitions and formats, disjointed and poorly defined business processes, and poor information access due to a diversity of user interface designs. The lack of integration hindered business process execution and effective decision making (Davenport, 1998). In an attempt to overcome the issues associated with poor IS integration, companies attempted to incorporate more and more functionality into stand alone systems. This has seen the advent of functionally specific systems such as Financial Management Information Systems (FMIS), Human Resource Information System (HRIS), Material Requirements Planning (MRP), Manufacturing Resource Planning (MRPII), and Computer Integrated Manufacturing (CIM), (Klause and Rosemann, 2000). The functionality offered by each of these systems was eventually integrated into one system in the early 1990's which was referred to as an Enterprise Resource Planning (ERP) system. ERP systems attempted to integrate all core business functionality into a single system with standardised definitions, user interfaces and a single database. The ERP system vendors also embedded business processes in their systems based on the implementation results noted at a number of leading companies. This enabled the vendors to claim that their systems incorporated "best practices". Thus an ERP system can be defined as information systems that are integrated, modular, have a broad business function and are responsible for transaction processing in a real time environment (Hawking et al, 2006).

The implementation of an ERP system results in the replacement of many existing information systems— but not all of them. The analysis of the information contained in the ERP system and the remaining legacy systems is important to monitor a company's performance. A data warehouse is the tool used to integrate the information contained in these systems in preparation for reporting and analysis. Accordingly, ERP system vendors

extended their solutions to incorporate BI system functionality, which has a data warehouse component to assist with this systems integration (Hashmi, 2003). Another driver for the uptake of a BI system as an extension of the ERP system's environment is the noted limitations of the ERP system with respect to reporting. Notably, ERP systems have extensive reporting features within each functional module such as financials and human resources however, cross-module reporting functionality is limited and impacts of the system's overall performance. Furthermore, ERP systems are limited in analysing historical trends and planning (Raden, 1999; Radding, 2000).

BUSINESS INTELLIGENCE

The use of IT to support various business processes has resulted in an exponential growth in the amount of data that is processed and stored. Traditional IT systems are efficient at capturing data and processing this data into information. However their ability to quickly provide flexible reporting functionality to better understand the information and its impact on the business is limited (Davenport and Harris, 2007). The need for improved information analysis and developments in related technology resulted in the evolution of existing IT systems and the emergence of new applications. These included Knowledge Management (KM), Data Mining (DM), Collaborative Systems (CS), Corporate Performance Management (CPM), Knowledge Discovery (KD) and Analytics. Recently, the term, Business Intelligence (BI) tends to be used to encompass all the previously mentioned systems (Gibson et al, 2004; Olszak and Ziemba, 2007).

BI can have a significant impact on a company's performance and therefore is considered a high priority for many firms. An early study by IDC (1996) found that companies that effectively used BI can achieve an average of 401 percent return on investment (ROI) over a three year period. In a Cutter Consortium (2003) survey of 142 companies, it was found that 70% of the respondents were implementing data warehousing and BI initiatives. Gartner (2009), a leading business analyst firm, conducted a worldwide survey of 1,500 Chief Information Officers and identified the BI area to be the number one technology priority. Accordingly, it is forecasted that BI system vendor revenue will reach $7.7 billion by 2012 (Sommer, 2008).

Although BI has the potential to improve the performance of a company, a review of the literature indicated that a significant number of companies often fail to realise the expected benefits of BI and sometimes consider the BI project a failure in itself (Chenoweth et. al., 2006; Hwang et al., 2004; Johnson, 2004). Gartner predicted that more than half of the Global 2000 enterprises would fail to realise the capabilities of BI and would subsequently relinquish market share to companies that had leveraged BI (Dresner et al, 2002). A survey, of 142 companies, found that 41 percent of the respondents had experienced at least one BI project failure and only 15 percent of respondents believed that their BI initiative was a major success (Cutter Consortium Report, 2003). Moss and Atre (2003) indicated that 60% of BI projects failed due to inadequate planning, poor project management, undelivered business requirements or those that were implemented were of low quality. It has been noted that in many BI projects that the information generated is inaccurate or irrelevant to the user's needs, or indeed delivered too late to be useful (Ballou and Tayi, 1999; Strong et al., 1997; Sheina, 2007). The National Computing Center (2006) in the United Kingdom found that the main driver for the implementation of BI was improving the quality of decision making however, the majority of respondents considered this expectation was not met.

Researchers have attempted to identify the factors which contribute to the success of a BI system implementation and the associated benefits that might be potentially realised (Ramamurthy and Sen, 2008; Srikant, 2006; Solomon, 2005; Shin, 2003) Hwang et al, 2004). These factors are often referred to as Critical Success Factors (CSF).

CRITICAL SUCCESS FACTORS

The concept of identifying success factors in business was first identified by Daniel (1961). He discussed these factors at the macro level whereby each industry would be reliant on three to six factors to an indicator success or failure. The tasks associated with these factors were required to be completed exceedingly well for a company to be successful. Rockart (1979) through structured interviews with chief executives further developed the concept of critical success factors. In the interviews he identified the executives' information goals and the underlying CSF. He argued that:

> "Critical success factors are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. They are the few key areas where "*things must go right*" for the business to flourish. If results in these areas are not adequate, the organization's efforts for the period will be less

> than desired. As a result, the critical success factors are areas of activity that should receive constant and careful attention from management". (Rockart, 1979 p. 85).

There have been numerous studies identifying the critical success factors associated with ERP system implementation and use (Holland and Light, 1999; Somers and Nelson, 2001; Summer, 2000). However, despite the recognition of BI as an important area of practice and research, relatively few studies have been conducted to assess how BI is undertaken in general and more specifically, what might be the pertinent critical success factors (Chenowth et al, 2006; Sammon and Adam, 2004; Srivastava, and Chen, 1999; Mukherjee and Souza 2003). The literature contains many practitioner's accounts of lessons learnt and guidelines for success but there is limited academic research (Farley, 1998; Atre, 2003; Rowan, 2003).

Watson and Haley (1998) in a survey of 111 organizations utilizing data warehouse solutions found that success factors included management support, adequate resources, change management, and metadata management. Farley (1998) identified that quick implementation, ability to adjust to business requirements, useful information, and ease of navigation as critical factors in a good data warehouse strategy. Chen et al (2000) in a survey of 42 end users found that user satisfaction was important for success of a data warehouse. Sammon and Finnegan (2000) adopted a case study approach and identified the organizational prerequisites for the successful implementation of a firm's data warehouse. They found that the successful organisational factors associated with implementation to be— adopting a business-driven approach, management support, adequate resources including budgetary and skills, data quality, flexible enterprise model, data stewardship, strategy for automated data extraction methods/tools, integration of data warehouse with existing systems, and hardware/software proof of concept. Wixom and Watson (2001) studied 111 organisations and found that data and system quality impacted on data warehouse success with system quality being four times as important as data quality. They further identified that system quality was affected by management support, adequate resources, user participation and a skilled project team.

The approaches and measures associated with the identification of critical success factors differ widely. Some studies measured implementation factors while others measured BI success. A summary of factors can be found in Table 1.

Table 1 BI Critical Success Factors

Author	**Factors**
Farley (1998)	Fast implementation, Ability to adjust to business requirements, Useful information, Ease of navigation
Watson and Haley (1997)	Management support, Adequate resources, Change management, Metadata management
Chen et al (2000)	User satisfaction
Sammon and Finnegan (2000)	Business driven approach, Management support, Adequate resources including budgetary and skills, Data quality, Flexible enterprise model, Data stewardship, Strategy for automated data extraction methods/tools, Integration of data warehouse with existing systems, Hardware/software proof of concept.
Little and Gibson (2003)	Management support, Enterprise approach, Prototyping data warehouse use, Metadata, Sound implementation methodology, External support (consultants)
Mukherjee and D'Souza (2003)	Data quality, Technology fit, Management support, Defined business objectives, User involvement, Change management.
Rudra and Yeo (2000)	Technical factors (data quality and data consistency, etc.)
Joshi and Curtis (1999)	Project-related factors (project plan must match with business demands and the scope of project management), Technical factors (DBMS selection, data loading, and efficiency of data access, etc.)
Wixom and Watson (2001)	Data quality, System quality, Management support, Adequate resources, User participation, Skilled project team.
Chenweth et al (2006)	Management support, Champion, Architecture (data marts), Organisational Fit/User Acceptance
Yeoh and Koronios (2010)	Management support, Clear vision and business case, Business champion, Balanced team, Iterative development approach, Change management, Suitable technical framework, Data quality

Wixom and Watson (2001) measured both BI implementation factors and BI success factors. Through a review of literature, survey of data warehouse conference attendees and interviews of data warehouse experts, the authors developed a research model for data warehousing success. Their model (Figure 1) attempted to demonstrate the interrelationship between the various factors and their impact on implementation success and/or system success.

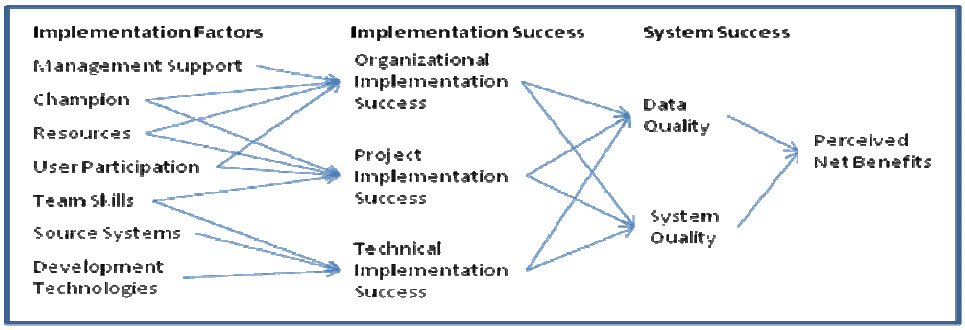

Figure 1 BI Success Model (Wixom and Watson, 2001)

One aspect of the Wixom and Watson (2001) BI Success Model is the lack of strategic factors that influence the success of a BI project. Although implied in the model other authors have emphasised the importance organisational alignment (Williams and Williams, 2003; Chenweth et al, 2006), defined business objectives (Watson, 2006; Hwang and Hongjiang, 2007), and an enterprise approach (Sammon and Finnegan, 2000; Little and Gibson, 2003) as important success factors in a BI project.

Many of the success factors identified from the literature in relation to the implementation and success of BI are not unique to the BI environment. Many of these success factors can be applied to other IS projects (Poon and Wagner, 2001; Karlsen et al, 2006) and have been noted in the implementation of portals (Remus, 2006), customer relationship management (Mankoff, 2001; Kim et al, 2002), knowledge management (Wong, 2005), supply chain management (Ngai et al, 2004) and geographic information systems (Crosswell, 1991). However, one success factor that is particularly unique to BI is the need to integrate data from various source systems. The successful integration of data is dependent on the number and type of source systems, the quality of these systems, the accuracy of each system's data, the metadata, and the ability for the BI to interface to these systems (Sammon and Finnegan, 2000). The increase in the number and diversity of source systems has a direct impact on this success factor. Vosburg and Kumar (2001) suggest that one way of improving the quality of data sources is to integrate the heterogeneous sources through the implementation of an ERP system.

For many companies BI has been implemented as an extension of their ERP system. The ERP system provides the data associated with business processes and their associated transactions while BI enables the analysis of this data to improve performance. The research associated with identification of BI critical success factors has been primarily performed on stand-alone BI systems— clearly a scenario that is unusual in the ERP environment where BI is closely integrated. Many of the success factors identified from the literature in relation to the implementation and success of BI are not unique to BI and can be applied to the implementation of ERP systems (Holland and Light 1999; Markus and Tanis 2000; Somers and Nelson, 2001). As indicated previously there has been a wide range of research associated with the identification of critical success factors relevant to ERP systems. There has been limited research associated with BI critical success factors. There has been no identified research associated with the identification of critical success factors associated with BI systems implemented as an extension of ERP systems. The ERP system success factors cannot be assumed to seamlessly apply to the more analytical solutions such as BI systems. Research to date has investigated the implementation of BI systems in the non-ERP environment— mainly in the realm of the successful implementation of the data warehouse that underpins the BI system's functionality.

RESEARCH METHODOLOGY

The objective of this research was to investigate critical success factors associated with BI in an ERP systems environment. The research analysed the applicability of existing CSF associated with the implementations of each of these systems to the implementation of BI systems as an extension of an ERP system. The aim was to determine the relevance of these factors and identify any new success factors not previously documented by the academic literature. In order to achieve the research objective, the following research question was used to guide the research:

What critical success factors are associated with the implementation of a BI system as an extension of an ERP system?

The study utilized qualitative methodologies to investigate the critical success factors associated with BI adoption. Qualitative research methods are "*aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context*" (Walsham 1993, p. 4-5). A qualitative research approach has been validated as being an appropriate form of investigation in the information systems discipline (Klein & Myers, 1999). The proposed methodology involved a content analysis strategy to appropriately confirm and/or identify new success factors pertinent to BI implementation. Content analysis can be viewed as a technique that allows the systematic examination of data in order to discern themes and contexts of interest. White and Marsh (2006, p. 22), "*characterizes content analysis as a systematic, rigorous approach to analyzing documents obtained or generated in the course of research*".

The content of industry presentations was examined and analysed to identify BI-associated critical success factors. Industry presentations refer to presentations by industry practitioners involved in the implementation, use, and maintenance of BI systems in an ERP systems environment. These could include presentations from users of the systems, system vendors and or implementation partners. Customers attend industry events to listen to presentations in an endeavour to get an appreciative understanding of the functionality of the system, future directions and developments, implementation and usage issues. Presenters are usually provided with guidelines from the event organisers as to how their presentation should be structured and formatted to ensure consistency and to provide value for the attendees. The presentations vary in duration from twenty to sixty minutes, and contain an assortment of information. The presentations could be in the form of a web cast, PowerPoint slides, transcripts, audio recording or a combination of these. The industry presentations are distributed electronically by the organising body and are freely available to attendees and/or associates.

Collectively, the presentations were used as a primary data source and were analysed for themes associated with BI systems implementation to identify any relevant critical success factors. These presentations were representative in detail and content of the typical industry experiences associated with BI systems implementation. The value of performing content analysis on industry presentations in an IS setting has been previously argued and documented by Yang and Seddon (2004). A weakness of their sampling was in using presentations from vendor conference— where presenters tend to espouse the virtues of their own products and services. Hence, vendor presentations may have included unsubstantiated claims and success stories. Whereas at conferences organised by user groups, the presentations often include both positive and less favorable reports of a vendor's product, service or solution— thus, providing valuable knowledge of best practices and critical success factors. Arguable, by obtaining presentations from the vendor and user group conferences, a more balanced view will be captured, than if only one type of presentation was used.

RESULTS

The sample for the content analysis was comprised of industry presentations sourced from a total of 69 SAP related industry events. SAP is the leading ERP systems vendor and for the past decade has provided a BI solution as an extension of their ERP system. Due to the nature of the events, and the associated costs with attending, presenters were predominately senior business personnel involved with the operation of BI systems in their company. A total 9,868 presentations were used as a source for the study and were located online or conference CD's. The organising body associated with presentations included SAP itself, SAP partners or SAP user groups in Australia, USA and Europe. Table 2 provides a breakdown of the sample by event organising body.

Table 2 Industry Presentations Sampled

Organising Body	Events	Industry Presentations
User Group	51	7,984
SAP	16	1,834
Partner	2	50

The majority of industry presentations sampled came from SAP user group events from USA and Australia. The main reason for this was the frequency of these events and their relative size. Companies and universities who are members of the SAP Australian User group (SAUG) are also members of the American SAP User Group (ASUG) and can access their website and conference presentations. The majority of the SAP organised events presentations are available via the World Wide Web. Either the presentations can be downloaded or conference proceedings on CD's can be ordered. However, SAP after a period of time remove access to older events. The limited number of industry presentations from partner organised events is associated with copyright

issues. These events are commercial events designed to make a profit and therefore industry presentations are only available to attendees. There are many of these partner events conducted each year especially in relation to BI systems however, industry presentations could only be sourced from two of these events.

The initial sample of 9,868 was found to have 842 (8.5% of the original sample) presentations related to BI. This was achieved by searching titles, abstracts and contents of presentations for terms which were associated with SAP BI. This sample was further reduced to 142 (1.4% of the original sample) presentations through two different methods. The first was to look for presentations which included the occurrence of any of the previously identified ERP systems or BI critical success as identified from the literature. The second method involved examining the presentations for slides associated with critical success factors, lessons learnt, recommendations, and or challenges. A content analysis was performed on the remaining sample to identify the critical success factors related to BI. The content analysis approach was similar to one adopted by Gardner and Wong (2005). The identified critical success factors and their frequency in terms of the number of industry presentations they were mentioned is displayed in Table 3. The factors which appear in the theoretical model are identified ([E, B]).

Table 3 BI Critical Success Factors

Critical Success Factor	**Frequency**
Management Support [E B]	33
Champion [E B]	4
Resources [B]	18
User Participation [E B]	42
Team Skills [E B]	42
Source Systems [B]	5
Development Technology [B]	0
Project Scope	21
Performance	8
Methodology [E]	24
Business Content	13
Governance	17
Reporting Strategy	6
Interaction with SAP	9
Testing	20
Data Quality	27
Training [E]	32
Involvement of Business and Technical	31
Change Management [E]	37
Implementation Partners	7
Identification of KPIs	3
Technical	71

[E] ERP system critical success factor. [B] BI critical success factor

DISCUSSION

A broad range of critical success factors were identified using content analysis. A number of these had already been noted in the previous research literature. Most of the factors with the highest frequencies (Management Support, User Participation, Team Skills) were noted in literature as being common to both ERP systems and BI. It was surprising that training and change management were not previously identified as BI critical success factors.

It became apparent after content analysis that the industry presentations reflected a practitioner's point of view. The presentations focussed on a particular aspect of a BI which the presenter's company was undertaking and the associated success factors. The type of BI activities and the associated success factors varied significantly across the presentations. These success factors had different perspectives and varied due to the functional s*olution* that was being provided, the type of a*pplication* and ones that had a t*emporal* feature. The Solution perspective refers to the component of BI being referred to in the presentation. SAP BI contains a broad range of functionality which companies choose to implement. Functionality could range from Strategic Enterprise Management (SEM) to Data Mining (DM), or be associated with a diverse range of reporting tools. Hence, some success factors were found to be specific to each Solution. The Application perspective refers to the application of the different solutions. For example a presentation focussed on the success factors associated

with the development of human resource BI reporting while another identified factors associated with building a financial dashboard.

The Temporal perspective refers to the various stages associated with the BI solutions life cycle. These stages range from the different phases of an implementation through to the effective use of BI. Success factors vary depending on which BI stage a company might be in. For example the success factor associated with the proper "Identification of KPI's" would be critical in the early phases of an implementation while the adequate "Performance" success factor is related to the later stage of an implementation. Related to this Temporal perspective is whether different BI solutions and their application had previously been implemented by the firm and at for how long a period this had occurred. Arguably, this introduces the concept of BI maturity. Success factors which may have been critical previously may not have the same relevance after a company has gained BI experience and addressed such factors. Figure 2 proposes the relationship between the Solution, Application and Temporal aspects of critical success factors.

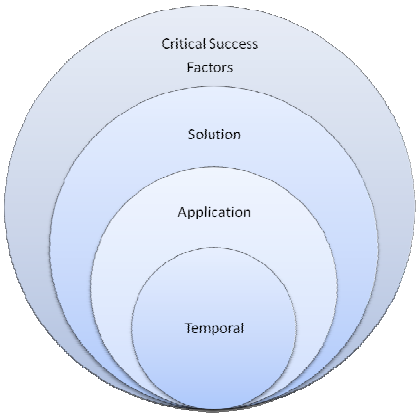

Figure 2 The Solution, Application and Temporal Aspects of BI Critical Success Factors

Certain critical success factors were found to be specific and could be easily grouped across both BI Solutions and Application. Notably some factors were classified as Technical (71) falling outside the three proposed spheres. Many of the identified critical success factors are closely related with 37 presentations (37) noting the importance of utilising both technical and business personnel on BI implementations. This could be inherent in the other success factor related to having adequate team skills on the project. The utilisation of both technical and business personnel is also critical to success on ERP systems (Sumner, 2000). There is arguably a relationship between factors associated with Source Systems and Data Quality. However, it is not clear as to wether these factors should be merged into one as the critical success factors associated with Source Systems are seemly more complex in function than is the case of Data Quality. Other factors associated with Source Systems include ease of data extraction, and ability to provide delta data (only data that has changed). Gartner asserted that the majority of BI projects would achieve limited acceptance, if not failure due to data quality issues (Hostmann, 2005).

One success factor that is inherently related to both ERP systems and BI implementations is having an appropriate approach or methodology when dealing with such systems (24 presentations documented this). However, it should be noted that methodologies of both systems are distinctly different. ERP systems are complex due to their level of integration. The impact on the organisation is significant as their implementation results in the removal of many legacy systems and the automation of many core business processes enterprise wide. The requirements are usually clear before the actual implementation. The ERP project methodology is structured due to the independency of activities and their impact on projects final success. In contrast a BI project's requirements often are "Ad Hoc" and develop over time. The BI project adopts a prototype methodology which evolves over time as new requirements are established. This "Ad Hoc" approach stills require good Governance (noted in 17 presentations) to ensure the overall BI initiative is consistent and stable facilitating future developments.

One critical success factor which has not been identified by previous BI research literature is the importance of Business Content (13 presentations). The introduction of an ERP system with SAP emphasises the critical role Business Content has in the implementation process. Business Content is associated with predefined structures and specific reporting which requires underling queries, metadata objects and extractors. Business Content has been developed for many of the key business functional areas of an organisation and can have a significant impact on implementation and is directly related to these predefined structures (Dimare and Winter, 2003)

CONCLUSION

Business Intelligence (BI) systems are highly reliant on ERP systems functionality and the vast amount of data that ERP systems generate. This paper argues that there was gap in the academic literature when it came to the critical success factors of BI systems implementation in an ERP environment. Through the application of content analysis to industry presentations, a number of critical success factors have been identified. This research provides a foundation for further researchers in a number of ways. It demonstrates the importance of industry presentations as a primary source of data that can be used to underpin research activities. Furthermore, the paper proposes that critical success factors should be considered from a Solution, Application and Temporal perspective. Further research is required to investigate each of the identified critical success factors.

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