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Success Factors for Data Warehouse and Business Intelligence Systems

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Abstract

Data warehouse (DW) and business intelligence (BI) systems are among the most important IT-based systems in organizations. The decisions made using these systems can fundamentally affect an organization's nature and performance. This paper reports the results of a case study that investigated the nature of DW/BI development. The theory lens used to frame and analyse the research was critical success factors (CSF). Ten CSF were identified from previous research on executive information systems, DW, and BI. This CSF set was used to analyse the failure of a corporate DW/BI project and the subsequent success of a smaller, functional BI system. To overcome previous criticism of the CSF approach, the CSF were analysed within the project's organizational context and in terms of the dynamics of CSF over the life of the project. The case provides a number of lessons for organizations embarking on enterprise-scale DW/BI projects. The study shows that the augmented CSF approach is useful in understanding DW/BI development.

Keywords

Data warehouse, business intelligence, critical success factors, case study.

INTRODUCTION

Data warehouses (DW) and business intelligence (BI) are at the forefront of the use of IT to support management decision-making (Gartner, 2007). DW can be thought of as the large-scale data infrastructure for decision support. In system terms, DW includes enterprise data warehouses, data marts, and applications that extract, transform and load (ETL) data into the data warehouse or mart (Watson, 2001). In many ways BI is the successor to executive information systems (EIS) and can be viewed as the data analysis and presentation layer that sits between the data warehouse and the executive decision-makers (Arnott and Pervan, 2005). Unlike previous generations of decision support systems (DSS), DW and BI are large-scale systems with budgets sometimes rivalling operational transaction processing systems. This increase in decision support scale can create significant challenges for boards, senior executive teams, and DW/BI developers. To investigate the nature of DW/BI projects, a longitudinal case study was commenced. The intention was to follow the project from pre-sales through evolutionary refinement and institutionalisation, a likely period of three years. Unfortunately for this strategy, the core project was cancelled after 15 months, after $1 million had been spent on requirements analysis, DW, data mart and ETL design, and BI analysis and presentation specification. A year later, a smaller functional BI application was successfully deployed.

This paper is organized as follows: first, the theoretical background that guided the research is summarized. This is followed by a description of the research methodology and design. The case study is then described from DW/BI project inception to cancellation, to the development of a functional BI system. This is followed by an analysis of the case in terms of the theoretical background. Lessons for DW and BI development are drawn from the analysis. Finally, the limitations of the study and directions for further research are presented.

THEORETICAL BACKGROUND

One way of understanding DW/BI development is to consider the relatively small number of factors that should be effectively addressed if a project is to succeed. These factors are called critical success factors or CSF (Rockart and DeLong, 1988). There are very few studies of DW and BI critical success factors. However, other research has shown that all management support systems (MSS) share fundamental concepts and research findings from one type of MSS can be transferred to another (Clark, Jones, & Armstrong, 2007). As a result research on CSF from personal DSS and executive information systems (EIS) can be used to inform DW and BI CSF.

Poon and Wagner (2001), using a multiple case study method, identified ten CSF that successful executive support projects mostly achieve. The CSF they identified 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. Poon and Wagner's set is based on a number of previous studies, in particular Rockart and DeLong (1988), Rainer and Watson (1995) and McBride (1997). Rainer and Watson (1995) identified 23 factors for successful EIS development based on interviews with 48 executives, EIS providers, and vendor/consultants. While Rainer and Watson's set is large it can be mapped onto a smaller, or critical, set. Salmeron and Herrero (2005) used an analytic hierarchy process (AHP) approach to understand and rank EIS CSF from 18 EIS users. In their hierarchy they clustered CSF as human resources (user involvement, competent and balanced staff, executive sponsor's support), information and technology (right information needs, suitable hardware/software), and system interaction (flexible and sensitive system, speedy prototype development, tailored system). Although these studies focussed on EIS, they provide a useful foundation for BI CSF.

Wixom and Watson (2001) conducted a survey-based investigation of the factors affecting DW success. They categorized these factors into three areas: organizational, project and technical implementation success. In particular they identified the micro-factors of management support, championship, resources, user participation, team skills, source systems, and development technology. These micro-factors contributed to one or more implementation success factors. Of importance is their concept of widespread management support as a replacement factor for the single operational sponsor of Poon and Wagner's EIS CSF set. Widespread management support is required to drive the organizational change that accompanies a DW project, especially overcoming resistance to change. Sammon and Finnegan (2000) investigated the organizational prerequisites for the implementation of a DW project. Based on four case studies they found these prerequisites to be: 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 DW compatibility with existing systems, and hardware/software proof of concept.

While the studies described above have developed, or supported, the concept of CSF for EIS/BI and DW implementation, other researchers have raised concerns about the approach. Nandhakumar (1996) examined the deep structure of an EIS implementation in terms of CSF. In addition to confirming the importance of the CSF set, he found that there are important interrelationships between the factors. Further, he argued, "understanding these interactions is crucial to explaining the reasons for EIS success and failure" (p. 70). Nandhakumar also found that CSF were not constant in their influence and importance during the life of the project. He highlighted the need for further research to understand the social context of EIS development and how this is manifested in CSF dynamics. The interrelated and dynamic nature of CSF could account for the failure of cross-sectional survey-based quantitative studies to verify the case study findings (for example, Bajwa et al., 1998). Bussen and Myers (1997) also criticised the factor approach to understanding EIS success and failure, arguing that satisfying a static CSF set is not a sufficient explanation for system outcomes. In an EIS failure case study in a 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 CSF set. This is supported by Wixom and Watson (2001) who in a survey-based study found that factors other than their variant of DW CSF affect data quality and success in DW projects. McBride (1997) supported the view that success factors are dynamic and influenced by the organizational context. Using the contingency framework of Poulymenakou and Holmes (1996), McBride found that a number of macro- and micro-contingent variables affected success in an EIS in a communications company. These included culture, planning, technical awareness, accountability, irrationality, evaluation, organizational structure, business environment, methods and methodologies, resistance to change, power and politics, strength of organizational need, and technology need.

Despite these concerns, CSF remains a useful construct for understanding what goes right or wrong in a DW/BI project. Importantly, they are readily understood by executives, managers, and IT professionals and can be an effective construct for moving theory into practice. The factors identified in the studies that are described above were combined to form the set displayed in Table 1. This set, well grounded in management support systems research, formed the framework for data collection and analysis. The criticism of CSF theory with respect to dynamics and organizational context was considered in the design and execution of the qualitative data analysis.

Table 1. Critical Success Factors for DW/BI Systems

Factor	Description	References
1. 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)
2. Widespread management support	DW/BI should be business driven with widespread management support. This helps manage the change process and overcome resistance.	Rainer and Watson (1995), Sammon and Finnegan (2000), Wixom and Watson (2001)
3. Appropriate team skills	Staff in the client organization and external suppliers should have appropriate knowledge, skills and experience.	Poon and Wagner (2001), Salmeron and Herrero (2005), Sammon and Finnegan (2000), Wixom and Watson (2001)
4. Appropriate technology	There should be a high degree of organizational fit with the DW/BI hardware and software.	Poon and Wagner (2001), Salmeron and Herrero (2005), Sammon and Finnegan (2000), Wixom and Watson (2001)
5. 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)
6. Effective data management	Operational data sources should be available. ETL applications should ensure currency, consistency, and accuracy. The data model should be flexible and extensible.	Poon and Wagner (2001), Rainer and Watson (1995), Sammon and Finnegan (2000), Watson et al. (2004), Wixom and Watson (2001)
7. Clear link with business objectives	The project should have a clear link with the business's strategies and be economically justified in terms of its business value.	Poon and Wagner (2001), Rainer and Watson (1995), Watson et al. (2004)
8. Well-defined information and systems requirements	Despite the difficulty of defining executives' requirements, the project should have an accepted definition of what is required from the system.	Salmeron and Herrero (2005), Rainer and Watson (1995), Poon and Wagner (2001), Watson et al. (2004)
9.Evolutionary development	A successful DW/BI system should be developed iteratively with strong user involvement, evolving towards an effective application set.	McBride (1997), Poon and Wagner (2001), Salmeron and Herrero (2005), Sammon and Finnegan (2000), Wixom and Watson (2001)
10. Management of project scope	The scope of a project can increase significantly. This can stretch project resources.	Lindsey and Frolick (2003), Rainer and Watson (1995)

RESEARCH METHOD AND DESIGN

The research used a single case study method. The case can be termed a critical case in that it aims to confirm, challenge, or extend well-formulated theory (Yin, 1994, p. 38). The selection of the case was opportunistic. The project studied was the development of an enterprise data warehouse with functional data marts and business intelligence applications in a financial services company. The development of these systems was outsourced. The researcher had unrestricted access to managers and project staff in all organizations involved. This included the Chief Finance Officer (CFO) and General Manager IT of the Financial Services Company (FSC), the CEO of the principal data warehouse vendor, Beta Consulting Company, and the Managing Director of a BI software vendor, Alpha Software. A condition of ethics committee approval for the research project was anonymity for all organizations and individuals. As a result, some superficial aspects of the case study have been disguised, including organizational names. The essential details of the case have not been altered.

The DW project was studied intensively for a 15-month period, from initiation to cancellation. In addition, interviews were conducted one year after the cancellation decision about a smaller BI application. The most rigorous method of data collection was formal interviews. The subjects of the formal interviews were FSC executives and managers, Beta Consulting executives and consultants, and an Alpha Software executive. The interviews ranged in length from 20 to 90 minutes. The interviews used protocols based on the theoretical background discussed above. All formal interviews were audio recorded and the transcripts were reviewed by the interviewees to ensure accuracy. Some participants requested that sensitive data be deleted from the transcripts. This process yielded 16 hours of usable recordings. The researcher also took part in semi-structured interviews and unstructured discussions with senior executives that, at their request, were not recorded. These informal sessions totalled 19 hours. The researcher took field notes during the sessions and recorded reflective commentaries as soon as possible after each meeting. In addition, the researcher was present as an observer in project meetings totalling 10 hours. These meetings involved both FSC and Beta Consulting personnel. As a

result, the total observation and interview time was 45 hours. In addition, participants made themselves available for telephone and face-to-face discussions to clarify issues during data analysis. Relevant project documents were made available including the company's IT strategy, project business case, gap analysis, governance structures, project management documents, data warehouse and ETL design, software and hardware selection documents, project costing, and project meeting agenda and minutes. No request for a document, interview, or meeting was refused by FSC, Alpha Software, or Beta Consulting. The details of the data analysis approach are provided after the case description.

CASE DESCRIPTION

Background

FSC is an icon brand in its market sector. Its operations are almost exclusively in one Australian state and it has an annual turnover of $500 million. The principal product of FSC is insurance; it has around 1.3 million policies in force. FSC uses an outsourcing strategy where possible and at the start of the case study a number of important functions were totally outsourced, including information technology, marketing, distribution, financial transaction processing, and funds management. As a result of this general sourcing strategy the company has only 350 direct employees. FSC has no IT staff and the outsourced IT contracts and service level agreements were the responsibility of the CFO. The relationship between FSC and the two outsourcing vendors for its operational IT is best described as poor. The contracts had been negotiated by a previous CFO who had little experience with large-scale IT systems. The new CFO had not negotiated an IT outsourcing contract before. He was interested in using both operational and DW/BI systems to improve the company's competitive position. The CFO believed that the operational systems provided by the vendors were outdated and had poor performance records. He was not confident that the current vendors could deliver state-of-the-art IT support for FSC in a timely manner.

The Beta Consulting Company was the primary contractor in the corporate data warehouse and BI project. Beta was formed by its CEO, a person with over 20 years of experience with IT in large organizations. An accountant by education, he had previously been an executive in the regional arm of a multinational consumer products company. In this role he was also responsible for the firm's IT. He created Beta Consulting to address the provision of IT support of executives from an executive, rather than a technical, perspective. At the start of the project Beta had 15 principal consultants. Their business model was to engage other personnel on a contract basis for each project as required. Although the FSC DW/BI project was the first total outsourcing project that Beta had embarked on, its consultants had many years experience in developing DW/BI systems in large organizations. In particular, the three principal consultants assigned to the FSC project were highly educated and had experience in successful DW/BI projects in both Australia and the UK. Beta is headquartered in a different Australian state to FSC.

Project Inception

The CFO of FSC attended a major regional finance conference. At the conference a number of DW/BI providers had stalls where finance executives could talk about their information needs and assess if the provider's products and methods were appropriate to their organizations. The Beta CEO and the FSC CFO had a number of fruitful conversations, and after the conference they met and agreed that Beta would undertake a gap analysis and feasibility study for an enterprise data warehouse for FSC. The main business driver for the CFO was improving financial analysis and reporting within FSC. He wanted to establish a consistent "enterprise-wide picture" of the corporation. There were long delays in getting reports; even regular standard reports such as claims statistics and portfolio analysis had eight-day turnarounds. From discussions with Beta's CEO he became convinced that a DW was needed to draw together the 13 different major IT systems that contained the data needed for financial analysis. He was attracted to the staged, evolutionary approach proposed by Beta's CEO. He wanted to "get some quick wins and get a bit more fire into the executive team." The first application areas that he wanted to address were financial reporting, and budgeting and forecasting.

Initial Development

In project documentation the project was called the Corporate Data Warehouse Program or "CDW" even though its scope also included functional data marts and BI applications. The initial work centred on building the business case for the DW. This was presented in two reports: a gap analysis and a business case. Based on these reports, a decision to undertake initial development was made by the CFO. The initial budget estimate was $600,000. According to the Project Definition Report, the objectives of the CDW project were: "enable fact-based decision making; provide a user friendly interface, provide a high level of security, provide fast performance, be flexible to accommodate future changes and enhancements."

Because FSC totally outsources its IT requirements, there were no FSC IT personnel for Beta to interact with, which made the initial design of data warehouse difficult. Beta placed one experienced DW designer on-site at FSC while other consultants travelled as required. A high-level design of the warehouse was completed. The environment of the CDW project was quite complex and there were 13 major operational systems that would feed the DW. A major difficulty was that external vendors held all the data sources. ETL design was a particular focus of the Beta consultants. Further adding to the complexity of the situation was the rapid expansion of the scope of the original corporate data warehouse and budget and forecasting BI application into six projects. The new projects that were added to the CDW banner were claims and portfolio reporting, strategic reporting, compliance and risk management, and actuarial support. In addition to the high-level design of the DW and data sourcing, Beta Consulting oversaw the selection of a BI tool. FSC purchased 10 licenses of the tool from Alpha Software.

After a major meeting that addressed the scope creep and governance of the project, a decision was taken to focus design effort on the finance area. The DW would be constructed, as would a finance data mart. This mart and its related reporting applications would provide DW/BI proof-of-concept that would inform other application areas. The architecture of the finance application is shown in Figure 1.

The Appointment of the General Manager IT

Two months after the decision to focus on finance, FSC appointed its first IT staff member. He was appointed as a general manager, a position one organizational level below C-level or executive status. It was unclear where IT should be positioned in FSC's structure and his reporting line changed in the first three months from the CFO to the Chief Operating Officer (COO), to the Chief Actuary. The General Manager IT (GM IT) had previously worked in a large UK insurance company many times the size of FSC. This was his first senior management position and the first time that he had held the most senior IT position in an organization.

The GM IT's first task was to understand the increasing number of significant IT issues and to develop an IT plan for FSC. In addition to the CDW project, these project areas included replacement of desktops and laptops, network infrastructure, business continuity, the FSC website, an eBusiness strategy, and the core operational insurance system. The CDW project was a low priority compared with some of these fundamental operational projects. A major focus of the GM IT was to consider the appropriate sourcing of each aspect of the IT portfolio. A decision was made by the Executive Committee to insource the general ledger and, when possible, desktop applications. In addition, a prima facie decision was made to insource the core insurance application (a likely $20 million project) and the GM IT was charged with conducting a tender process. The IT function of FSC soon had six personnel.

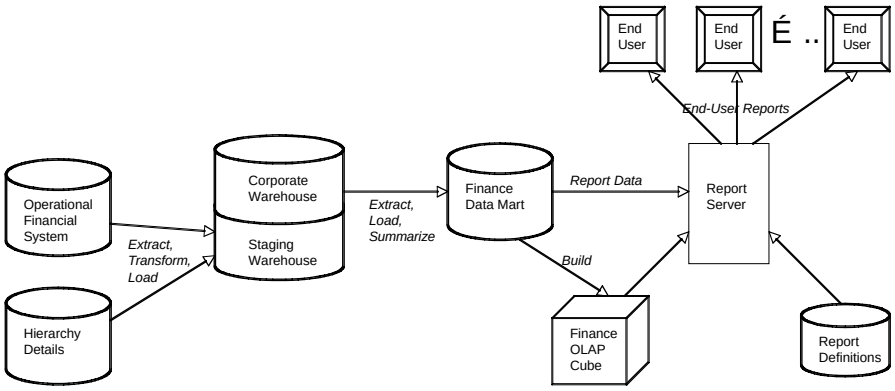

Figure 1: The Finance Data Mart and Business Intelligence Architecture

The GM IT introduced a formal project management approach to IT projects in FSC. He mandated the use of Prince2 for all projects by FSC staff and also mandated its use by external contractors including Beta Consulting. Prince2 (www.ogc.gov.uk/prince2) is a large-scale methodology for planning, directing and managing projects. It was developed by the UK government and is a de facto standard for managing large projects in the UK. Coming from a large UK company, the GM IT was very familiar with Prince2. Beta Consulting used its own systems development methodology that was developed with management support projects in mind. The Beta consultants involved in the CDW project undertook basic Prince2 training in order to comply with the new FSC reporting requirements. The structure of the CDW governance changed with the

creation of a Project Board. The Project Board was chaired by the CFO and included the COO, GM IT, and Beta CEO.

CDW Project cancellation

Following the appointment of the GM IT, the Beta consultants continued to focus on the finance application as the proof-of-concept and the data warehouse as the major decision support infrastructure. No firm agreement was reached with the operational system vendors for access to the required data. Twelve months from its inception, the CDW project was "put on hold." Two months later the project was cancelled by the Executive Committee on the advice of the GM IT. He then added data the warehouse and BI application to the core insurance system purchasing process. No decision support had been delivered by the CDW project and close to $1 million had been spent on hardware, software, and Beta Consulting services.

The GM IT had a low opinion of the work performed by Beta and wanted to involve a British accounting firm with experience in insurance-related BI in a green-field project. The Beta CEO in turn had a low opinion of the processes introduced by the GM IT and believed that the project had been "throttled by Prince2." The CFO was frustrated by lack of any delivery of functionality during the year and felt that he was partly frozen from effective management of the project. He was also frustrated by the nature of his involvement with Prince2.

The Beta CEO related that he thought that the first version of the CDW and finance data mart were one to two months from delivery. Interviews with the developers and inspection of the artifacts confirmed that this delivery estimate may have been feasible. One year after the cancellation of the CDW project and the bundling of DW/BI with the core insurance system, a proposal for this large set of systems was endorsed by the Executive Committee and sent to the Board of Directors for approval. The Board rejected the proposal.

The Budgeting and Forecasting BI System

Despite the problems with enterprise-wide DW and BI projects at FSC, some IT-based management support had been delivered to executives. The plans for the UK accounting firm to provide a prototype BI application did not eventuate and the CFO assumed control of the budgeting and forecasting application from IT. Budgeting and forecasting was his original business driver for the CDW project. After many attempts, FSC's IT group was unsuccessful in installing the BI software that was purchased from Alpha Software early in the project. The CFO engaged Alpha to install the software on a FSC server and write the ETL code to populate the BI application database on a continuous 15-minute update schedule. The Alpha consultants reused some of the work completed by Beta Consulting, but unlike Beta in the CDW project, they did not have to use Prince2. The General Manager Planning (who reports to the CFO) became the operating sponsor, with the CFO the executive champion. The budgeting and forecasting application was delivered in an evolutionary manner. The CFO reported high satisfaction with the development process and outcome, and has plans for the corporate-wide rollout of future versions to all executives and general managers.

ANALYSIS AND DISCUSSION

Data analysis method

The 312 pages of interviewee-verified transcripts were loaded into a number of within-case displays for analysis (Miles and Huberman, 1994). Each display or matrix was created by isolating relevant text fragments during a complete reading of the transcripts. These passes yielded a time-ordered matrix (Miles and Huberman, 1994, p. 110) for each CSF. In addition, a time-ordered matrix was created for the Budgeting and Forecasting BI System. This matrix presented a view of the application orthogonal to the 10 CSF matrices. During the CSF analysis two important sub-factors of the Appropriate Team CSF emerged. These were situational inexperience and key person relationships. Additional time-ordered matrices were created for these sub-factors.

To overcome the criticism that CSF theory ignores the dynamic nature of factors over the life of a project, the analysis considers the case in three eras: the early stage of the CDW project, from inception to the appointment of the GM IT; from the appointment of the GM IT to the CDW project cancellation; from the CDW project cancellation to the deployment of the Budgeting and Forecasting BI System.

For each era a conceptually ordered display (Miles and Huberman, 1994, p. 127) forms the foundation of the analysis. These displays are summarized in Tables 2, 3, and 4. In arriving at the assessments in the tables, interpretation of the data from the CSF time-ordered matrices was combined with the organizational context from the case description, information from project documents, and interpretation of field notes and reflective commentaries. In each of these tables, the success factors from Table 1 are scored on a three-point scale of attainment: yes, partly, and no. A similar approach and assessment scale was used by Poon and Wagner (2001).

Success Factors for the First Project Era

Table 2 shows the analysis of CSF in the first era of the CDW project, from project inception to the GM IT appointment. The CSF scores indicate that, at this time, the project had a moderate likelihood of success. The two CSF with a 'no' score and four with 'partly' scores show the areas of concern for the project. It is possible that the 'partly' scores could have been turned into 'yes' scores with careful management and time. However, the two 'no' scoring CSF are of serious concern.

Table 2. Critical Success Factors for the First Project Era

Factor	Assessment	Attainment score
1. Committed and informed executive sponsor	The CFO was a committed and enthusiastic sponsor with a clear vision of improving executive decision making in FSC. He championed the CDW project to the CEO and Executive Committee.	Yes
2. Widespread management support	Early in this era the number of managers involved was small. After the governance meeting a wider range of executives and managers became supportive. The project was business driven.	Partly
3. Appropriate team	Beta CEO and consultants were highly experienced. FSC did not have any IT staff. Relations with the operational outsourcers were strained. Business executives and managers had appropriate knowledge and skills but this was the first time any participant had been involved in outsourced DW/BI provision.	Partly
4. Appropriate technology	Ten BI tool licences were purchased from Alpha Software. The desktops (Windows 95) were unable to run contemporary software.	Partly
5. Adequate resources	The original budget was approved by the CFO and CEO. The CFO made rapid decisions on hardware and software purchases.	Yes
6. Effective data management	All transactional data was held by other organizations. There were unacceptable lags in download times.	No
7. Clear link with business objectives	Despite the lack of a formal IT strategy, the CFO had a clear vision of how the CDW project fitted with FSC's strategies and objectives.	Yes
8. Well-defined information and systems requirements	Gap analysis and business requirements reports were submitted. The CFO had a clear view of high-level requirements. No detailed BI systems requirements were available.	Partly
9. Evolutionary development	Beta used an evolutionary approach with the support of the CFO. There were explicit objectives of proof-of-concept and a quick win in the data mart and BI components of the project.	Yes
10. Management of project scope	The original focus on budgeting and forecasting and the corporate data warehouse expanded to six distinct projects. This expansion was poorly coordinated.	No

The four CSF with strong attainment scores show a project with enthusiastic sponsorship, a clear link between the project and the objectives of the Executive Team, adequate resources (with rapid decision-making on resource requests), and the use of an evolutionary development approach that was accepted and embraced by the business users and sponsor. Of the 'partly' scoring CSF, three were trending in the right direction. Management support was widening as the CFO brought more managers into the project dialogue in the wake of the governance meeting; the obsolete desktop technology was scheduled for urgent replacement with the outsourcing vendor; appropriate BI software was purchased; and the information and systems requirements were defined at a high level with considerable activity underway on the definition of detailed specifications. The 'partly' factor that was most problematic in this era was the nature of the team executing the CDW project. All of the executives, managers, and consultants involved in the project were high performers in their own fields. However, all were inexperienced in key aspects of the CDW project. The CFO had not been responsible for IT contracts before and Beta, as an organization, had never worked on a totally outsourced DW/BI project before. As a result, these experienced professionals had little experience in the situation that they were dealing with. This sub-factor can be termed 'situational inexperience.'

Of the two 'no' scoring CSF, the management of project scope was the easiest to overcome. FSC had been unable to react to improvements in IT because of a lack of internal IT expertise and restrictive arrangements with the outsourced operational systems. As a result, the interaction between FSC and Beta personnel released the latent demand for IT innovation. This demand was also fuelled by stricter regulatory authority requirements after a major insurance company collapse in Australia. The expansion in scope was unfortunate as the core DW/BI project was already stretching Beta's resources. The strong 'no' score for effective data management is the most problematic for the CDW project. At this stage there were seemingly insurmountable difficulties in routinely sourcing the requisite data in a timely way from the two operational outsourcing vendors.

Success Factors for the Second Project Era

The appointment of the GM IT was the most significant perturbation in the life of the CDW project. The appointment was made by the CEO because he thought that the total outsourcing of IT was a major risk for the future of FSC; he wanted to bring some of the core IT systems directly under FSC's control. The early priorities

of the GM IT lay with building the foundation of an in-house IT function. As a result, the CDW project was relatively low on his priorities. As he had never been responsible for an IT function before and was new to the Australian insurance industry, the GM IT appointment added significantly to the situational inexperience of the actors in the CDW project.

Table 3 shows an assessment of the project in its second era, from the appointment of the GM IT to cancellation of the CDW project. The CSF scores show a project in fatal decline. In addition to the analysis of CSF, Table 3 has an additional column that indicates the dynamics of each factor. Only one CSF had improved from the first era, four were unchanged, and five had declined. The most significant contextual difference between these two eras was a change from the project being business driven to largely IT driven.

Table 3. Critical Success Factors for the Second Project Era

Critical success factor	Assessment	Attainment score	CSF direction
1. Committed and informed executive sponsor	There was confusion as to whether the CEO, CFO or GM IT was the executive sponsor. The GM IT was not appointed at an executive level.	Partly	Decline
2. Widespread management support	The project became IT driven. The GM IT had a poor opinion of the project and this was known by other managers and executives.	No	Decline
3. Appropriate team	Beta hired two additional highly experienced consultants in relevant areas. The GM IT was new to the management of an IT function. The FSC IT personnel had an operational systems focus. There was tension between FSC IT and Beta.	No	Decline
4. Appropriate technology	FSC IT was unable to install the BI tool. Desktop upgrades commenced.	Partly	Unchanged
5. Adequate resources	Before cancellation, budget escalation was partly driven by the Prince2 implementation. After cancellation, the bundling of DW/BI with the core insurance system replacement caused a significant delay.	No	Decline
6. Effective data management	There was a clear understanding of what data was needed and where it was. No contracts or agreements for data sourcing were reached and no data was available to test the finance data mart. The download lags were unchanged.	No	Unchanged
7. Clear link with business objectives	The GM IT developed an IT Plan that was approved by the Executive Committee. The IT Plan included DW/BI provision.	Yes	Unchanged
8. Well-defined information and systems requirements	Detailed compliance and risk management requirements were completed and the high level DW/BI requirements were waiting approval. The detailed DW requirements were poorly documented while the finance data mart and associated reporting were well specified.	Partly	Unchanged
9. Evolutionary development	The development philosophies of Beta and FSC IT were in conflict. The particular use of Prince2 had a significant effect on the nature and speed of development. No "quick win" prototype was delivered.	No	Decline
10. Management of project scope	The planning and project control structures introduced by the GM IT effectively controlled the project's scope.	Yes	Improvement

One of the principal forces behind the significant decline in the CSF scores was a clash of systems development philosophy between Beta and the new FSC IT function. Prince2 can be used to support evolutionary development, but it originated in a large-scale linear development environment, and this heritage is evident in its philosophy, documentation, and processes. Beta had its own evolutionary methodology, tuned for the development of DW/BI systems, and the clash of these philosophies placed major strain on the project. A Beta consultant, who had Prince2 experience in the UK, reported that FSC's use of the methodology "was like using a sledgehammer." The senior Beta consultant, who was the project manager, related:

> "So, conceptually, I don't see the requirement to use Prince2 to manage the project as an impediment. Unfortunately, the incarnation of Prince2 that [GM IT's name] requires *is* an impediment to it…..it's almost like the methodology has become the end, not the means."

This consultant had an excellent background for the project, having previously worked in the DW area of Australia's largest insurance company. He was in a good position to understand the impact of large scale IT philosophy on the CDW project. As project owner, the CFO was also frustrated with his interaction with Prince2. He related:

> "I started reviewing some of the documentation that was being produced, and the problem is one of them calls one of them "a Prince2 definition". They call a product, something that's generated from the project. So a document can be a product, and it was a document, it was a product definition about a product about a process. So it was a document which I read, and it told me about another document, and when I read that, it was a document about a process …."

The CFO later commented on the impact of the particular implementation of Prince2 on the Budgeting and Forecasting BI System: "They were using the Prince2 methodology for that as well and that one just got ridiculous. It was supposed to be a fairly simple, low cost project, but ended up blowing out in cost terms a bit."

Beta's lack of delivery of a small prototype system in the BI part of the project was another reason for the decline in CSF ratings from the first to the second era. From the start of the CDW project the CFO was very clear that he wanted a "quick win" to build commitment across all management for improved decision support. All staff in Beta, from the CEO down, must have been aware of this strategy. What is surprising is that they did not deliver a prototype of either the budgeting and forecasting or claims reporting applications. Small prototypes could probably have been delivered without the DW being in place. Instead, effort was placed on the data warehouse and ETL design, effort that made significant progress but which was invisible to senior executives.

The third major force behind the project decline in the second era was the nature of the relationships between key Beta and FSC personnel. In the first era there was a close relationship between the CFO and Beta CEO. The Beta CEO had been a CFO earlier in his career and they had a common world-view. They frequently spoke of trust being the core of the interaction between FSC and Beta. The relationship between the Beta CEO and the GM IT was not as close and, unfortunately, it deteriorated over the last months of the CDW project. The mandatory Prince2 compliance was a focus for discontent on both sides. The breakdown of relationships between the key actors affected seven of the CSF (1, 2, 3, 4, 6, 8, 9).

Success Factors for the Third Project Era

Table 4 shows an assessment of the project in its third era: the delivery of the Budgeting and Forecasting BI System after the CDW project was cancelled. The CSF scores show a project with an overwhelming chance of success. Every CSF with a neutral or negative score in the second era had been reversed to a 'yes.' The Budgeting and Forecasting BI System was the target of the business need that initiated the CDW project. It was a small application relative to the enterprise data warehouse, data marts, and BI applications of the large-scale failed project. It wasn't based on a DW or data mart and its main data feed was the newly insourced general ledger system. As a result it benefitted from learning from the CDW project failure.

Table 4. Critical Success Factors for the Third Project Era

Critical success factor	Assessment	Attainment score	CSF direction
1. Committed and informed executive sponsor	The CFO initiated and funded the system. He effectively championed the system to the Executive Team.	Yes	Improvement
2. Widespread management support	The project was business driven with strong support from finance managers.	Yes	Improvement
3. Appropriate team	The GM Planning became a key developer after training. Alpha Software installed the software and contracted for some of the development. The FSC IT function was not involved.	Yes	Improvement
4. Appropriate technology	Alpha Software installed BI tools and the desktops were upgraded (Windows XP).	Yes	Improvement
5. Adequate resources	The budget was approved by the CFO.	Yes	Improvement
6. Effective data management	Effective ETL from the general ledger system was developed by Alpha Software reusing some of the work performed by Beta.	Yes	Improvement
7. Clear link with business objectives	There was a strong link to corporate strategy, the IT plan, and the informal vision of CFO.	Yes	Unchanged
8. Well-defined information and systems requirements	The system requirements were well understood by the CFO and the developers.	Yes	Improvement
9. Evolutionary development	An evolutionary approach was adopted with the business unit developers working with Alpha Software consultants. The CFO had a clear idea of which modules were needed and the desirable sequence of development	Yes	Improvement
10. Management of project scope	The project scope was well understood and controlled. A phased rollout of system modules was planned to all executives and general managers.	Yes	Unchanged

CONCLUSION

The theory lens of CSF has proved useful in helping to understand what went right and wrong in the FSC case. Nandhakumar (1996) and Bussen and Myers (1997) highlighted the need to understand the organizational context of BI development. Nandhakumar (1995) and McBride (1997) also identified that CSF were not constant in their effect over the life of a project. In this study, the use of a detailed case description made the organizational context clear. Further, by dividing the data analysis into three natural eras, the dynamics of the CSF have been uncovered. This analysis of the change in individual CSF scores over different eras has contributed significantly to the understanding of the case. This provides stronger evidence for the robustness of the CSF set than a one-shot case study. In the FSC case a number of forces drove the CSF change. They became

visible by framing the qualitative analysis with CSF and building conceptually ordered displays of the emerging concepts. This goes someway to overcoming a criticism of the CSF approach, in that the interaction of the CSF with contextual factors was part of the analysis.

The ten DW/BI CSF that were derived from previous research were found to be effective in explaining project success and failure. In the FSC case, two CSF stand out as being of major theoretical interest: an appropriate team and evolutionary development. With respect to the methodology CSF, the identification of the clash of systems development philosophies between FSC IT and Beta highlights an important area of research. There will be an increasing pressure in industry for large-scale operational IT approaches to be applied to the large-scale decision support of DW and BI. Another important lesson from the FSC case is not to interfere with outsourcing vendors at the systems development methodology level. Outsourcing projects should be controlled by contracts that focus on outcomes rather than vendors' internal processes. A further lesson from the FSC case is to be vigilant for environmental triggers of DSS evolution. The consequences of the appointment of the GM IT were to a large extent predictable. Whenever such an evolutionary trigger occurs, the project strategy should be fundamentally reviewed.

This study has used CSF theory to analyse a case after the event. It may also be possible to use CSF as a predictive theory of DW/BI project outcomes. By undertaking CSF analysis at key stages of a project, the business and IT personnel involved in the project may be able to identify problems before they become serious. The CSF analyses could be the subject of discussion in governance committees like the FSC Project Board. They could then institute corrective action based on their understanding of the state and direction of their project's CSF. Such analysis may have helped in the CDW project.

The Budgeting and Forecasting BI System provides a number of lessons. The first is that BI development should be driven by business units and controlled by a senior non-IT executive. The development team and technology were appropriate and the project was adequately resourced. A key factor in the system's success was the availability of source data. This smaller project shows that although DW and BI are closely linked in industry practice, a BI implementation can be successful without a DW to provide it with data.

The first limitation of the study relates to the reliability of the data collection and analysis (Yin, 1994, p. 36). To help improve reliability, a case protocol was developed based on the theoretical background of the project. In this way reasonable reliability was achieved, as another researcher could have collected similar data using this protocol. The second limitation concerns construct validity (Yin, 1994, p. 34). This is a particular problem for this style of case study because the analysis and interpretation of qualitative data is partly subjective. This limitation was minimised in this study by verifying findings (or acknowledging conflict) through multiple data sources, having participants validate transcripts, and through clarifying phone calls and emails to participants. A major limitation of the research is the difficulty in generalising the results of the single case study to other engagements, its external validity. In a critical case study the research focus is to confirm, challenge, or extend theory. The augmented CSF theory, distilled and tested in this study, should be applicable to other DW/BI projects. However, only further research can verify its relevance and robustness.

Further case studies are needed to investigate DW/BI CSF. This is because the deep structure of projects needs to be revealed to understand the forces that drive the CSF. Further case studies should investigate the clash and alignment of systems development methodologies, the relationship between BI and DW, and the appropriateness of the CSF set. In addition, design-science research is needed to investigate the use of CSF as a predictive tool in DW/BI development.

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