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Journal of Strategic Information Systems 8 (1999) 351–371

Strategic Information Systems

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Unpacking the systems development process: an empirical application of the CSF concept in a research context

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Accepted 8 May 2000

Abstract

This paper unpacks the black box of the IS development process and, thereby, helps business and IT managers understand better its complexity. The Critical Success Factors (CSF) concept was employed for this purpose in an in-depth study of four diverse systems development projects in a large telecommunications company. Unlike previous applications of the CSF method, the approach adopted in this study facilitated the identification of both 'generic' and 'collective' CSFs in order to map the network of interrelationships between them. Thus the findings shed new light on the process by which information systems are developed by illustrating empirically its complex multidimensional nature and by providing fresh insights into the challenges facing both developers and users in their task of developing organisational IS.

Keywords: Critical Success Factors; Information systems development; Interpretive case study; Hermeneutics

1. Introduction

The management and application of information technology (IT) has become critical for the success of business enterprises. As IT managers struggle to keep pace with business and technological change, they are faced with the challenge of developing increasingly complex information systems (IS). Systems development is, in essence, a multi-dimensional change process that takes place simultaneously within several related social environments. These environments give rise to a complex web of social conditions and factors

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0963-8687/99/$ - see front matter
PII: S0963-8687(00)00027-5

that shape and influence the IS development process and its outcomes (Kling and Scacchi, 1982). The idiosyncratic nature of the development process poses a significant challenge for IT managers as evidenced by the number of abandoned projects and costly systems failures reported in the literature. The challenge facing researchers is, therefore, to unpack the black box of the systems development process and to investigate the roles played by project managers, developers, and users; the development methodologies, tools and techniques they employ; and the multifarious influences on the trajectory of the development process from its surrounding environments.

Researchers argue that the systems development process is best studied using an interpretive approach (Myers, 1995; Butler, 1998). Nevertheless, while interpretive techniques satisfy the rigour of academia, conceptually they are far removed from the practical everyday experiences of business and IT managers. Rockart's (1979) CSF concept and method has received a wide acceptance among business and IT professionals and is employed in a variety of organisational contexts. In an academic context, researchers recently demonstrated that the CSF concept is interpretive in character and as such it may be employed for research on the systems development process (Butler and Fitzgerald, 1998). On the other hand, the concept's relevance to practice hinges on its ability to express the social reality of organisational life in a language familiar to managers. At a practical level, the CSF approach helps the researcher and practitioner abstract from the complex, multi-dimensional reality of business activities, such as systems development, and focus on core activities that are critical for business success. This study's objective is to identify a 'generic' set of CSFs for the system development process that will signpost areas for managerial attention; however, as this paper illustrates, a holistic understanding of the development process can only be achieved by delineating the complex network of interrelationship between underlying 'collective' and 'generic' CSFs—that is this study's central contribution, something which has not been a feature of previous research.

The remainder of this paper is structured as follows. Section 2 introduces Rockart's CSF concept and reviews previous CSF research, indicating the diverse contexts in which it has been employed. Section 3 describes the research approach adopted for this study, while Section 4 presents and analyses the findings. In the latter section, four key systems development projects in a large Irish telecommunications company, Telecom Eireann, are studied to identify and describe the 'collective' and 'generic' CSFs for the systems development process. An integrative analysis is presented, which contributes toward an in-depth understanding of the dynamics of the systems development process. The final section then presents the paper's conclusions.

2. The CSF concept

The use of a CSF approach for IS planning was developed at MIT's Sloan School of Management. Subsequently, Rockart (1979) employed the method to determine the key information needs of top executives. The genesis of the critical success factor approach in a managerial context that incorporates a role for information systems was first delineated by Daniel (1961, p. 111) who argued that an IS should focus on small group of "success factors", the "key jobs [that] must be done exceedingly well for a company to be

Table 1
Summary of research on CSFs in the IS discipline

Area of application of the CSF concept	Rationale for the application of the CSF concept and method and research objective	CSF approach employed/ Researcher
IS development process	CSFs associated with the information systems development process have been explored in four studies. Recent research into the CSFs for EIS development found that 8 CSFs emanating from several development-related social contexts influenced EIS development (Nandakumar, 1996). Another study unearthed some 23 CSFs for IS development (Sumner and Ryan, 1994). Phan et al. (1995) surfaced a set of CSFs for project management of large software development projects. Finally, Krcmar and Lucas (1991) investigate the success factors for strategic information systems.	Interpretive, case-based study (Nandhakumar, 1996). Survey-based field study (Sumner and Ryan, 1984). Case study-based (Krcmar and Lucas, 1991). Survey-based field study and exploratory case study (Phan et al. 1995).
IS executives	Studies by Rockart (1982) and Martin (1982a,b) were the first to explore this area. A recent study by Pollalis and Frieze (1993) used a standardised set of 35 CSFs, drawn from the literature, and relating to the IS function management to test their hypothesis that CSFs evolve over time. The study: (a) validated past findings regarding the traditional set of CSFs for IS executives; (b) reported on new CSFs related to the long-range focus on strategic planning and competitive advantage; (c) identified differences in CSFs across different organisations and industry sectors; and (d) confirmed that CSFs evolve over time.	Case study-based CSF interview approach (Rockart, 1982). Survey-based field study (Martin, 1982a). Field study incorporating original CSF interview approach (Martin, 1982b). Survey-based field study (Pollalis and Frieze, 1993).
IS function evaluation	Building on Martin's (1982a) initial research, Ragahunathan et al. (1989) investigated the relationship and impact of IS executives' CSFs on IS function performance. Ragahunathan et al. illustrated that IS function performance, as measured by a particular set of indicators, was significantly related to the operationalisation of IS manager CSFs.	Survey-based field study (Ragahunathan et al. 1989).
IS performance measurement and evaluation	Slevin et al. (1991) explored the use of the CSF approach to measure and enhance the performance of the IS function. The focus of this research is orientated towards the services provided by the IS organisation and thus explores the subset of CSFs that underlie the service/operations CSFs of IS executives as delineated by Rockart (1982). Slevin et al. utilised the CSF method to develop specific performance measures and to track performance in a complex IS environment.	Group workshops and informal communication within the IS function (Slevin et al. 1991).
Data administration	Guynes and Vaneck (1996) determined the CSFs for data and database administration functions in the IS departments in organisations.	Field study incorporating both interviews and a survey Guynes and Vaneck (1996)
Information resource planning	Research has shown that CSFs enhance communication between an organisation's general management and the organisation's IS function. Studies have illustrated that this is accomplished through the provision of a 'common schema' which both groups can easily comprehend, aiding the alignment of business strategies with the corresponding IS strategic and functional imperatives. The executives'/managers' objectives, goals, CSFs and associated performance measures that represent the stated CSFs aid the identification of corporate information needs and in the subsequent development of a corporate information systems plan and/or development of individual IS.	Case study-based CSF interview approach (Rockart, 1979). Case study-based modified CSF interview approach (Boynton and Zmud, 1984; Shank et al., 1985). Case study-based modified CSF interview approach with group workshops (introductory, focusing, decision scenario) (Rockart and Crescenzi, 1984). Case study-based original CSF interview approach (Pellow and Wilson, 1993; Byers and Blume, 1994).

Table 1 (*continued*)

Area of application of the CSF concept	Rationale for the application of the CSF concept and method and research objective	CSF approach employed/ Researcher
Requirements analysis	Several studies sought to investigate the utility of the CSF approach to the determination of the information requirements of senior and middle management. Managers' information requirements, as indicated by goals, CSFs and associated performance measures and standards, are elicited as part of the corporate and business planning process.	Field study incorporating original CSF interview approach (Munro and Wheeler, 1980). Case study-based modified CSF interview approach (Boynton and Zmud, 1984).
Information function planning	Boynton and Zmud (1984) report that CSFs can induce a structured design process for eliciting both MIS plans and managerial information needs. Strategic and policy roles for CSFs within the IS function planning context revolve around their use as a tool to identify those issues that merit close management attention within the IS function itself. Improved IS function policy and strategic and tactical planning are said to accrue as a result.	Case study-based modified CSF interview approach (Boynton and Zmud, 1984).
Strategic information systems planning	A CSF-based strategic planning approach has been described by researchers (Lee and Adams, 1990; Shank et al. 1985). Henderson et al. (1986) created a planning context for CSF use and provided a means to analyse the critical assumptions underlying CSFs and the decision processes that are instrumental in their achievement. The resultant set definitions-i.e. the critical information, decision and assumption sets-then became the basis for a functional analysis of the requirements for MIS, DSS and ESS, respectively; and, also, provided important insights into the organisation's *strategic data model.*	Case study-based modified CSF interview approach (Henderson et al. 1986; Shank et al. 1985). Note: Lederer et al. (1988) report that a number of the more 'popular' strategic IS planning methodologies (SISP), e.g. Business systems planning and information engineering (Martin, 1986), use the CSF approach, in conjunction with a SISP method.
Information centre research	There is an established body of CSF research on information centres (IC). This research has concentrated on the success of IC in their assigned role of facilitating and co-ordinating end-user computing. Operating from a number of different perspectives, and contrasting applications of the CSF approach, researchers have attempted to determine the existence and nature of CSFs for ICs.	Multi-site case study and CSF interview method (Sumner, 1985). Telephone structured interview/survey approach (Wetherbe and Leitheiser, 1985). Survey-based field study (Magal et al., 1988; Magal and Carr, 1988; Leitheiser and Wetherbe, 1991).
Evaluation of information systems	In a CSF study on the evaluation of information available for planning and control, the usefulness and availability of information critical to the accomplishment of managerial work in a health care organisation was assessed. Zahedi (1987) adopted a conceptual approach to arrive at a method for quantifying the reliability of IS based on their CSFs.	A case study-based approach incorporating CSF interviews, surveys as well as group meetings (Bergeron and Bégin, 1989). Theoretical analysis (Zahedi, 1987).
Analysis of the CSF Concept and method	Several researchers have critically examined the CSFs concept: Davis (1979, 1980) for example outlined four characteristics of human behaviour that might effect the application of the concept. Munro (1983) performed an evaluation of the seminal studies on IS executives. Zahedi (1987) evaluated the reliability of IS based on CSFs formulation and posited a CSF hierarchy. Lehner (1993) extends the CSF method to include statistical success factor analysis. A critical review of the CSF concept involving an "informal, intuitive, interpretive analysis of the CSF literature" was conducted byWilliams and Ramaprasad (1996, p. 257). Although implicit in the extant literature, these researchers posited four different levels of criticality for CSFs, and three sets of dichotomous attributes.	Theoretical analysis (Davis, 1979, 1980). Meta-analysis of Rockart's (1982) and Martin's (1982a,b) CSF research (Munro, 1983). Theoretical analysis (Zahedi, 1987). Twin Survey-based field studies (Lehner, 1993) Taxonomic meta-analysis of previous literature. (Williams and Ramaprasad, 1996).

successful." Other seminal contributions are to be found in the writings of Anthony et al. (1972), who reported that CSFs were different across organisations, and also between managers within individual organisations; Zani (1970) who illustrated that key success variables (e.g. CSFs) might identify the most important elements of a firm's success and, thereby, help specify priorities for IS development; and King and Cleland (1971), who argued that critical decision areas[1] had a major role to play in information requirements analysis and in the design of information systems. All this prompted researchers in the IS field to investigate the informational role of CSFs (see Mooradian, 1976; Rockart, 1979). This research found a home in MIT and culminated in Rockart's seminal paper on the subject in 1979.

The CSF approach, as conceived by Rockart, is essentially an information systems planning methodology for top level management; however, he later used the approach to conduct research on the roles of IS executives (see Rockart, 1982). Rockart (1979, p. 217) defines critical success factors as:

> The limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation. They are the few key areas where "things must go right" for the business to flourish. If the results in these areas are not adequate, the organisations efforts for the period will be less than desired.

The CSF method thus attempts to make explicit these areas, and their associated information needs, such that IS appropriate to these requirements can be planned and developed. Bullen and Rockart (1986) later extended the application of the CSF concept to other managerial levels within an organisation. Focusing on the organisational information systems planning process, they suggest that the CSFs of managers at multiple levels within an organisation be obtained to arrive at a 'collective' set for the entire organisation. This 'collective' set is then aggregated to arrive at what Rockart (1982, 1979) termed a 'generic' set. Information resources and activities may then be targeted at enabling the enterprise to realise these 'collective' and 'generic' CSFs.

Since the original application of the CSF concept and method for defining the information needs of business executives, the CSF approach has been applied by practitioners and researchers in a number of areas (Bryers and Blume, 1994). Table 1 provides a detailed analysis of previous research on the CSF concept; the data in this table illustrate that the concept has been utilised successfully in many areas within the IS discipline, it also reveals that diverse methods have been employed by researchers to operationalise the concept.

It is clear from the research presented in the table that a coherent set of CSFs for the IS development process has not emerged form previous efforts to operationalise the concept in what is regarded by many to be the core of the IS field (cf. Cotterman and Senn, 1992; Hirschheim et al., 1996). In addition, many researchers argue that the process by which information systems are developed is not well understood (see Myers, 1995 and Lewis, 1994, for example). The proposed research objective of identifying a comprehensive set of

[1] It is evident from the King and Cleland's (1971) research paper that critical decision areas are basically synonymous with CSFs.

CSFs for the systems development process attempts to contribute towards this gap in extant research.

3. The research approach

In keeping with the original CSF method, a qualitative, case-based research strategy was adopted for the conduct of the study. Here, a single case with four embedded units of analysis (i.e. four systems development projects) were purposefully selected to conduct 'post-hoc longitudinal research' on the systems development process (Yin, 1989). The case was selected on the basis of its similarity to many large commercial organisations in terms of its systems needs, and because its management considered IT to be a chief enabler in securing the company's future commercial success. Two of the projects selected for study were strategic information systems while the remaining two were important operational support systems. A total of 38 interviews took place with social actors participating in systems development in the organisation, viz. IT project managers and developers; IT managers in the development environment; and social actors in the organisational environment—user representatives and user project managers were considered to be representative of 'world views' in the relevant user constituencies. Thus, following Lee et al.'s (1991) injunction regarding the management of self-report bias in studies on IS development, both user and developer 'world-views' were apprehended; this allowed a comprehensive set of IS development-related CSFs to be identified. While the formal interviews were up to two hours long, many informal conversations took place between the researcher and the actors concerned; comprehensive documentary sources were also consulted. In an overall context, the study was guided by Visala's (1991) extension of the Ives et al. (1980) research framework: here, Visala advocates the interpretive hermeneutic and teleological approaches for research on the systems development process (see Butler, 1998, for a detailed discussion of these issues). The analysis of the research data was informed by these approaches and conducted using the qualitative data analysis techniques of content and constant comparative analysis (Patton, 1990; Calloway and Ariav, 1991). Triangulation techniques were also extensively employed to provide insights into the relationships that existed between primary data sets (Patton, 1990; Erlandson et al., 1993). A network analysis (see Miles and Huberman, 1994) of the 'collective' and 'generic' CSFs was performed in order to present and analyse the data in a condensed format and to illustrate the complex nature of the phenomenon; extended narratives were employed to provide additional detail and context.

4. The case: telecom Eireann's IT directorate

The primary unit of analysis in this study is the IS function—the Information Technology Directorate (ITD)—of a large Irish telecommunications company, Telecom Eireann (now eircom). At the time of the study[2] the ITD comprised eight operational divisions, four of whom undertook systems development for the parent organisation. The IT Director

[2] The directorate was restructured in 1998 and again in 1999.

may be categorised as an IS executive following the criteria defined by Pollalis and Frieze (1993) and described by Rockart (1982). Two managerial layers report to the director—IS function managers and their systems development project managers.

As previously indicated, in order to understand the process of IS development in this large organisation, four heterogeneous systems development projects were chosen for study. Table 2 provides an overview of these systems, two of which—the Generic Appointment System and Geographical Information System—are operational support systems, the other two—the Corporate Data Warehouse and the Telephone Information System/Flexible Tarrifing System—being strategic information systems. Table 2 also lists the 'generic' CSFs for each development project. In keeping with this study's research strategy, the systems development-related perspectives of the IS executive and his IS function management team were first ascertained; these provided important contextual data on development-related policies and plans. Following this, the development-related CSFs of business users, project managers and developers were uncovered. Fig. 1 describes the process by which the CSFs for the systems development process were arrived at. This process began with the identification of individual 'generic' CSFs of social actors, then collating and integrating individual CSFs to arrive at a 'collective' set for each project, and, finally, analysing these CSFs to uncover a 'generic' set for each project (Rockart, 1982; Bullen and Rockart, 1984). The aggregation of these 'generic' project-specific CSFs gave rise to a 'collective' set of CSFs for systems development as it occurs in this organisation.

A meta-analysis conducted on the basis of a cross-project aggregation and ranking of 21 'collective' CSFs (see Fig. 2) that emerged from the initial analysis of CSFs for the four development projects studied surfaced a 'generic' sub-set of nine CSFs (those in dark grey boxes in Fig. 2) for the IS development process in Telecom Eireann. The research data on each of the development projects indicated that the 'generic' CSFs had been influential in shaping the development process in each and in determining development outcomes. The ranking of 'collective' and 'generic' CSFs was achieved through the interpretive analysis of the qualitative data using the techniques of content and constant comparative analysis. For example, the number of times a CSF was mentioned or referenced by interviewees was one indicator; another was the relative weight placed upon it by social actors. The researcher's interpretive apparatus and understanding of the case details were of particular relevance here.

The 'collective' set of CSFs for Telecom Eireann's development process is presented in the form of a network analysis[3] in Fig. 2 that illustrates the web of influences and inter-relationships between these CSFs.

The various relationships that exist between the 'collective' set and the 'generic' subset emerged from the analysis of the research data. Many of these interrelationships were explicit and were clearly articulated by project managers, users and developers; others were less obvious and surfaced during the data analysis phase of the research process. In Fig. 2, primary focus is given to the role of the 'generic' sub-set of CSFs shown in dark grey. The unbroken arrows indicate a strong level of influence between CSFs; the broken arrows signify a weaker level of influence; and double-sided arrows indicate a reciprocal

[3] See Miles and Huberman (1994) for a description of this data analysis, display and reduction technique.

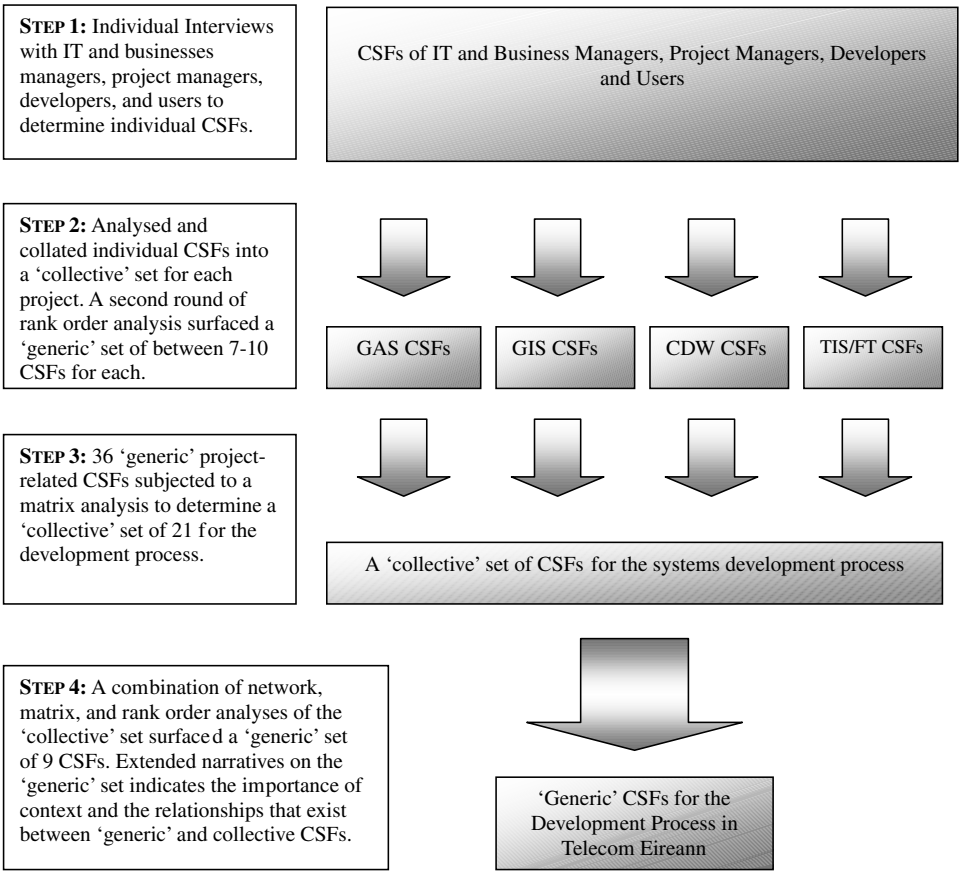

Fig. 1. The process of CSF elicitation adopted in this study.

relationship. For example, the CSF that deals with project management activities (CSF2) has a reciprocal influence on the time spent on requirements analysis (CSF4), and has a strong influence on increasing communication and conflict between team members ('collective' CSFs). Conversely, the successful attainment of this CSF was shown to be dependent on the use of structured development methods, prototyping and CASE tools. Therefore, beginning with any of the 'collective' or 'generic' CSFs, and examining their *loci* within the network of the CSFs shown, the reader can identify the interdependencies that exist between CSFs and, hence, arrive at an understanding of the role that they play in describing the development process. Hence, it is evident that CSFs are not discrete phenomena, rather, they constitute a complex hierarchical web of factors that require attention if successful outcomes to the process of systems development are going to be achieved. The following extended narratives explore the development process from the perspectives offered by Fig. 2.

4.1. CSF 1: Ensure low-level user representation/participation at all stages of the systems development process

CSF 1 deals with the importance of the type and degree of user participation in the systems development process. In the organisation under study, a participative approach to decision making throughout the company ensured a high degree of user participation in systems development, both direct and indirect. This added to the complexity of the development process, as various institutional factors had to be taken into account. The degree and quality of user participation was found to be influenced positively by IS function management and negatively by business managers and the labour unions. For example, a decision taken in the IS function and organisational environments to site development projects in the client's place of business greatly enhanced the quality of end-user participation. In previous projects, the reluctance of business managers (or objections by the staff unions) to release key personnel to participate in systems development had influenced negatively the quality of end-user participation, placing developers on-site helped address such issues. The benefits of a participative approach to the development of IS were recognised by developers, viz. "the development team benefited from the presence of the user-representative. I was up to speed all the time; otherwise it may have degenerated into a them [users] and us situation." Developers, therefore, welcomed pan-lifecycle user participation to the extent that significantly more access to users was desired; the user constituency confirmed this position. One highly beneficial side effect of the participative nature of the development process in this organisation was that it has generated a positive impact on the awareness, by developers, of users' perspectives and the relevant business issues. It was clear that having a committed project sponsor ensured that user participation/representation "happened" as the most knowledgeable and skilled end-users were made available for participation in the development process. The "end-to-end" nature of user participation was also perceived by business managers to serve the change management objective of user acceptance of developed systems.

4.2. CSF 2: project estimation, planning, tracking to agreed targets, co-ordination and control of project activities

Project planning, estimation of project-related activities, tracking these activities and their co-ordination and control was influential throughout the development process of each of the projects researched. Project estimates were based on the outcome of the requirements analysis; and if these estimates were sub-optimal then the resulting definition of project scope was inaccurate and, hence, project planning was also affected. As one project manager put it, "the critical factor at the beginning was getting an agreed set of requirements down to a low enough level that would allow us to estimate how long [the project] would take." It was also pointed out that the outcome of the requirements analysis is, in part, dependent on the amount of time the project manager assigns to it, and, more importantly, on his ability to secure suitable users to participate in the project. In a related vein, observations made by another project manager, who had the responsibility of project managing a rapid application development (RAD) approach incorporating prototyping, indicated that "a structured approach to project management along the lines of the SDLC

Table 2
Development project and associated information systems characteristics

System	Function and characteristics	'Generic' Project-related CSFs
Geographic Information System (GIS)	The GIS was developed to provide a graphical database of the telephone network in the general Dublin area. Prior to its development, the planning and drawing office functions manually recorded network-related details using paper-based records and maps. The GIS development team consisted of a project manager, two analysts, three programmers, two user representatives, and a team of ten users to input graphical data and carry out test functions. Consultants from the software vendor also participated in the development process. The GIS was built around a proprietary graphical database engine that serves up to 40 high-end workstations. The first phase of the GIS development took almost two years to complete. Implementation and rollout of the first phase took a further year. Project over-runs occurred in terms of both time allocated for completion and budget.	1. Obtaining an appropriate level of useful vendor support. 2. Sufficient human resources (developer and end-user testers etc.) must be made available to the project team. 3. Ensure low-level user participation at all stages of the ISD process. 4. Adequate time needs to be spent, with the relevant end-users, to elicit user requirements. 5. Coordination and control of the both user and development project teams (using regular project team meetings etc.). 6. Having a committed project sponsor. 7. Ensuring that business client/end-user industrial relations/change management issues related to the ISD process and product are resolved prior to the commencement of the project.
Generic Appointment System (GAS)	The GAS supports the operation of the company's ten fault-handling and repair centres and customer service team supervisors in allocating workloads to repair and service provision teams, especially in the area of scheduling customer appointments. Both the internal fault handling staff and external operational teams therefore had a keen interest in the development and implementation of this system as it impacted on some of their basic functions. A development team that consisted of a project manager, two analysts, the IEF CASE vendor consultant (Texas Instruments), one programmer and a user representative carried out the development of the GAS. A CASE-supported RAD development approach saw development take place within a three month time period: however, the implementation of the first phase of the GAS took a further six months. As a distributed IS, the GAS is comprised of 8 relational databases that serve up to 180 windows-based PC terminals in fault-handling centers and a further 400 in operational depots nationwide. The project was on time and budget.	1. Adequate time needs to be spent, in active (interviewing) and passive (observation), with the relevant end-users, to elicit user requirements. 2. The use of prototyping techniques/ CASE tools to determine and refine user requirements. 3. Ensuring that business client/end-user industrial relations/change management issues related to the ISD process and product are resolved early on in the project life cycle. 4. Obtaining an appropriate level of vendor support (for all products used in the ISD process including CASE environments etc.). 5. Siting the IS development team within the user community enhances user/developer communication and promotes user acceptance of the IS. 6. Ensure low-level user representation/participation at all stages of the ISD process.

Table 2 (*continued*)

System	Function and characteristics	'Generic' Project-related CSFs
		7. Overcoming the technical obstacles associated with the implementation of a client/server architecture. 8. Ensure intra-team conflict is minimised where CASE tools, that facilitate multi-skilling of team members, are employed. 9. The availability of structured development methods and supporting CASE tool environments. 10. Perform comprehensive and effective end-user training as part of the IS implementation.
The Corporate Data Warehouse (CDW)	The CDW provides a database platform for the organisation's decision support systems (DSS). As such, it provides an information 'superstructure' or 'gateway' between the organisation's operational support and transaction processing systems. Built around a scalable Teradata DBC1012 machine incorporating massively parallel processing, the development was conducted in-house with vendor assistance. The development project is ongoing-since 1991, as data from the broad range of existing and proposed systems are integrated into the warehouse. The approach is evolutionary, and no specific methodology or CASE tools were employed in its development. The CDW development team is also in the process of developing and upgrading organisational DSS. They are a range of such applications in all functional areas within the company: the CDW may also be accessed directly from any terminal (2,000 +) on the company's network, subject to proper authorisation. At present, there are 10 developers and two full-time user representatives on the team.	1. Have a committed project sponsor at senior management level. 2. To have active end-user participation throughout the development process. 3. Effect efficient extraction and transfer of data from corporate IS to the warehouse. 4. Ensure that the project is tightly managed, with clear project goals. 5. Developers have to possess an awareness and appreciation of business issues to see things from the business point of view. 6. End users need to understand the data content of the CDW. 7. Ensure that an adequate level of documentation is attained. 8. Ensuring that adequate support is obtained from the vendor(s) in development of the IS. 9. Constructing a comprehensive, fully normalised, flexible and adaptable business data model on which to base the warehouse. 10. Improve end-user computer literacy and competency with applications.

Table 2 (*continued*)

System	Function and characteristics	'Generic' Project-related CSFs
Telephone Information System/Flexible Tariffing Project (TIS/FT)	The TIS is the company's mainframe-based transaction processing system; its serves over 2,000 on-line and networked terminals. The Flexible Tariffing System was integrated into the TIS as a new subsystem. Its role is to enable the introduction of a range of customer tariff plans, allows calls to be rerated, and support the implementation of marketing promotions and customer discounts. The TIS/FT is a large-scale project that involved the joint development of the new system by an Israeli software vendor and the ITD's own developers. Basically, the software vendor tailored an existing package to meet Telecom's own needs, while a large team of in-house developers and users (28 approx.) integrated and tested the new subsystem. Development and testing of the system took approximately one year.	1. Ensure that the development project is well planned, coordinated and controlled. 2. Have a focused development steering group with overall responsibility for IS development. 3. Developers need to understand the business issues and users' needs. 4. Understanding the existing legacy IS. 5. Employing end-user-representatives throughout the systems development project. 6. Possess effective inter- and intra-project communication between the various project participants/ constituencies. 7. Employing prototyping, CASE tools and techniques, where necessary, to support and accelerate IS development. 8. Ensure that the IS is well documented. 9. Fostering a close working relationship with the application vendor.

does not work in such cases…it does not match what developers are doing in reality on the ground." This made life quite difficult for this individual project manager as various trade-offs had to be made to stay on time and within budget.

In this study it was clear that the co-ordination of intra- and inter-project activities was of particular relevance, especially, since each project had both a user and development project manager. Project meetings were held on a regular basis to help give effect to co-ordination and control of project activities. The importance of regular project meetings was underlined by one developer, who stated that they "act as a forum for developers to keep abreast of each other's progress and activities. Also, the user and ITD project managers keep us abreast of external issues such as industrial relations problems…project activities are monitored/reported on a weekly basis…this has been very good for morale." Also, project managers and developers were very conscious of the "us vs. them" issues that arise between the various groups involved in systems development: a high degree of formal and informal communication (ranging from face-to-face and telephone to e-mail communication) was established between the participants to counter this negative side-effect—indeed, project managers, developers, and, also, users appeared to go to great lengths to avoid such problems.

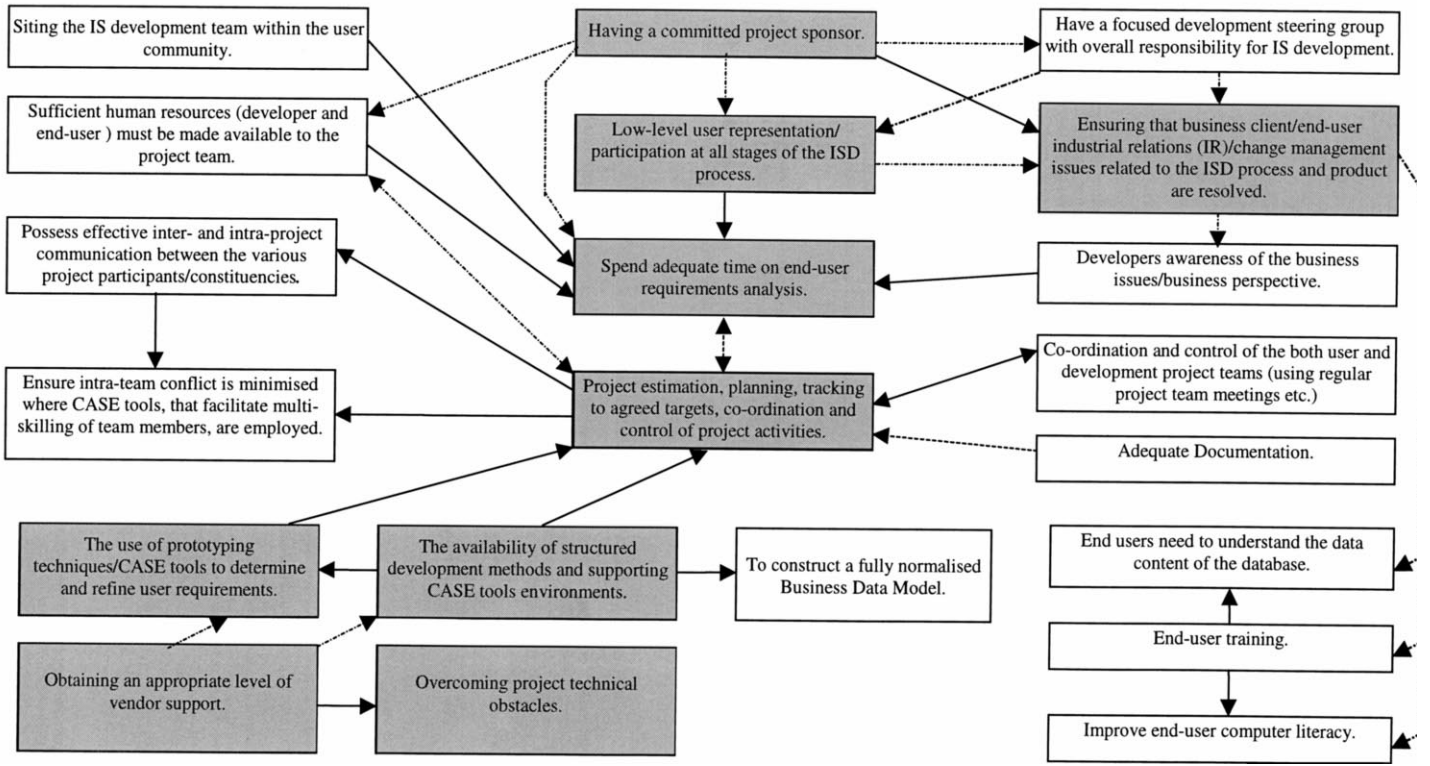

Fig. 2. A network analysis of ‘collective’ and ‘generic’ CSFs for the IS development process.

4.3. CSF 3: obtaining an appropriate level of vendor support

Two of the projects studied herein utilised vendor application packages to develop highly complex information systems; one was tailored off-site by the vendor (the TIS/FT), the other was developed in-house by the company's own developers with vendor assistance (the GIS). In the development of both these applications, a considerable emphasis was placed on requirements analysis; however, significant difficulties were experienced with the elicitation of requirements in one of these projects—the GIS. This was attributed to the unique and complex nature of the requirements for a geographical information system. All in all, developers did indicate that requirements analysis was equally as important for the development of systems using vendor supplied application packages, as for the custom-developed in-house systems. It was clear that the issue of vendor support was dominant throughout systems development. For example, obtaining an adequate level of vendor support, when development related problems arose, was considered to be critical by all developers. In the GIS project, problems arose with the development application package, as the project manager pointed out: "There were major bugs in the system…a lot of to-ing and fro-ing with the [vendor]…there was an official logging procedure for reporting such events but we did not know about it…this led to a breakdown in communications…a lot of the suggestions made by the [vendor] were counterproductive and led us down dead ends." IT managers also had an important role to play in the escalation of vendor-related issues that impacted on the development trajectory. Project managers and IT managers were mindful of the level, quality, and extent of post-development support by the application vendor.

Other, no less significant, vendor related support issues related to the solution of technical problems in the implementation sub-process, and the resolution of use/technical difficulties with Texas Instrument's IEF CASE workbench used to develop the GAS. This involved the implementation of a new client/server architecture. Here, the project manager responsible indicated that "getting the signalling protocols for the GAS and the existing FHS (fault handling system) to work together was problematic, in that one (the FHS) was DIGITAL's, the other IEF's (for the GAS), in the end of the day we had 3–4 weeks of very technical assistance from Texas Instruments to get the systems to work together." This, however, was not the only vendor-related issue that arose in relation to the IEF CASE workbench: as this was the first time the company had used CASE to develop a system, vendor training and support issues were found to be critical to the success of the workbench's use for systems development.

4.4. CSF 4: adequate time needs to be spent with the relevant end-users to elicit user requirements

The importance of developers spending adequate time on end-user requirements analysis was not lost on project managers in this organisation: one manager put it in a nutshell: "If I was starting out a project and I was asked what the CSFs are, the premier CSF would be to tie down the [user] requirements." The research findings indicate that decisions relating to the time allocated to this activity are often outside the ambit of the development team. For example, decisions made by managers in the organisational and/or IS

development environments were taken in reaction to external conditions, and not in consideration of development process realities—all this impacted on the time set aside for requirements analysis. Although a CSF in its own right, having a committed project sponsor has a bearing on the type and quality of end-users/representatives made available for the requirements stage, and for maintaining high levels of participation throughout the development process.

4.5. CSF 5: the use of prototyping techniques/CASE tools to determine and refine user requirements

It was apparent that the impact of a deficient and/or complex requirements analysis may be offset through the use of prototyping: according to a user representative, "what was perceived as a requirement, quite often was not; prototyping drove [the actual requirements] out…what we started out with and ended up with was totally different." In addition, it was argued by developers that prototyping also "gave the user a sense of presence and ownership of the system…they could actually see the changes they recommended." There were tangible benefits in terms of end-user communication with developers, and a visible preference by developers for the use of prototyping in all projects, even if the particular development approach did not facilitate it. However, it was pointed out that the development of prototypes indicates a heavy reliance on prototyping tools (either CASE based or 4GLs): a suitable tool has, therefore, to be used, preferably one embedded within a CASE environment, that can produce a working prototype. The use of sophisticated CASE tools also implies the availability of appropriate levels of vendor support, as was reported in the above.

4.6. CSF 6: ensure that business client/end-user industrial relations (IR)/change management issues related to the ISD process and product are resolved

The development trajectories of two of the systems researched (the GAS and GIS) were altered due to resistance from the user constituency; this resistance occurred due to the changes, wrought by the introduction of the system, to the work-related roles and conditions of users. In both projects, significant alterations had to be made to system functionality, and the systems were implemented on a limited basis in pilot sites. However, in respect of one project, the GIS, IS function management had intervened, and had resisted any radical change to system functionality because it was felt that this would degrade the effectiveness of the system. Because of such issues, the implementation of both projects was delayed. Of note here is the fact that the users and user-representatives participating in these development projects accepted both systems as developed. However, users operating through an outside agency, the labour unions, influenced the post-development implementation of the systems. It was widely regarded, by both developers and users alike, that change management issues must be addressed early on in the development process, particularly if systems development-related industrial relations difficulties are to be avoided.

4.7. CSF 7: having a committed project sponsor

The vital nature of top management commitment to the process and product of systems development was evident in each of the projects studied; this type of support manifested itself chiefly in the initial stages of the development process, e.g. in the provision of budgetary and human resources—developer and user—and ensuring that political and change management issues are addressed. For example, the CDW user-project manager stated that: "The most important thing in this project was its sponsorship, if it was left to us middle managers it would have not gotten off the ground." The existence of political opposition within the organisation can also be mitigated as, in two of the aforementioned projects (the CDW and TIS/FT), it was noted that "political positioning was not an issue and did not impede the projects progress due, chiefly, to the sponsor's role." And, in relation the CDW project, it was also stated that "while the ITD contributed the necessary technical resources to do the technical research work… [the project] was too big and too expensive to run with for the ITD, without the commitment of a senior end-user."

It was also clear that ongoing high-level management support is vital for the resolution of change management issues. One important point in relation to this CSF, and neglected in much of the extant literature, is that top management support has to be more than just involvement/participation at the early stages, or iteration, of a system's development life cycle. Rather, with an evolutionary/iterative approach to systems development, this support has to be maintained to the same degree throughout, irrespective of any personnel changes at managerial level, or change of emphasis due to other business imperatives, if the ongoing success of the development process is to be assured.

4.8. CSF 8: the availability of structured development methods and supporting CASE tools/environments

The effectiveness of the structured methodology (information engineering—IE) embodied in the IEF CASE environment utilised in the GAS project won the praise of all members of the development team: as one developer put it, "the methodology does enforce a rigorous approach to development, it was really good." Another developer added that "the development environment was absolutely superb, there was enormous savings in terms of coding, program management was enabled." Yet another stated that the developed system "was more maintainable, better documented, better developed, and afforded better communication with the users through its modelling and prototyping facilities" and "[it was] very powerful and versatile in the area [of data/process modelling] as models are built with integrity that is maintained throughout." The take-home message here is that no two systems are identical, and neither are their development approaches; hence, the methodologies embedded in CASE cannot be followed slavishly; due recognition has to be given to immediate development needs and proposed features of the target system. For example, IEF was also employed by the Israeli vendor of the TIS/FT sub-system; however, the off-site vendor could not utilise the CASE workbench code generator due to the requirement for a 'tightly coded' application that would efficiently manage database

activity and throughput. This code had to be hand-crafted to optimise database performance.

Comments made by one analyst illustrate the existence of means-end inversion, whereby, developers tend to get caught up in the means, e.g. adhering to every methodological step religiously, at the expense of getting on with the development this possible down side: "SSADM was the flavour of the month some years ago…but the perception at the time was that it slowed things down, the delivery of systems were late, productivity was down because developers were too busy drawing boxes and lines and going into minute detail." This latter weakness of structured methods was mentioned by other developers as been instrumental in the abandonment, by the development function, of SSADM for function-wide analysis and design. Prior to the IS function's initial experience with SSADM, there was no function-wide standard relating to the use of system development methodologies or CASE. However, in the absence of any central/managerial guidance on such issues many developers are using their own imported techniques, often utilising a pen and paper or a word processing/presentation application for documentation purposes. It has also been the case that individual project managers introduced methods/techniques/CASE tools for particular development endeavours: for example, SSADM was resurrected for use in the GIS project.

In an organisation such as Telecom, where analysts and programmers are graded differently, and receive differing remuneration, there is the potential for intra-team conflict resulting in industrial action by either group. In the GAS project, where such problems could have arisen, the project manager ensured that an intra-team consensus existed prior to the start of systems development; this was said to have avoided an outbreak of intra-team conflict. According to one team member: "As developers we came together and agreed a common approach to the system's development…no 'us and them', either within the team or between developers and users…nevertheless, it must be said that IEF has the potential for conflict."

4.9. CSF 9: overcoming project technical obstacles

The technical problems encountered in all projects were not insoluble: however, they did call for the application of significant technical skills and expertise on behalf of the developers and vendors. Briefly, these obstacles arose due to problems with the introduction of client/server architectures, interface and data transference, technical problems with the development of the corporate data warehouse, evaluating suitable hardware platforms, problems with the optimisation of off-line batch code, problems with the integration of a vendor application package with existing systems, and technical problems associated with the integration of data protocols used by a vendor's IEF CASE workbench with those of existing operating systems.

5. Conclusions

This paper has provided a comprehensive analysis of the CSFs for the IS development process in one organisation. In doing so, it has contributed to the cumulative body of research on both the CSF concept and method and in research on the systems development

process. The implications for research are first explored in this concluding section, and following this the implications for practitioners are considered.

The CSF method, however operationalised and applied, can fall prey to the accusation of being reductionist; and, indeed, this is true of many studies where CSFs have been presented without reference to the necessary contextual data that would illustrate how, as important 'parts', they contribute to an understanding of the socially-constructed 'whole' of the phenomenon of interest. In explicating what this study has identified as the 'generic' CSFs for the systems development process in the organisation studied, the research findings have illustrated that IS development-related CSFs are closely interrelated; furthermore, they influence each other and the strength of this influence can vary. In addition, it is clear that the CSFs cannot be considered in isolation from their socio-structural and contextual dimensions if their full impact on related social phenomena is to be comprehended. The latter was evident when the 'generic' CSFs for the systems development process were subjected to a descriptive network analysis. It was also evident that 'non-generic' CSFs give context and meaning to the 'generic' set (i.e. the remainder of the 'collective' set). All this implies that researchers should not treat CSFs as discrete component phenomena when presenting and analysing research findings in relation to the topic of study, and that practitioners should attempt to probe beneath CSFs to comprehend fully their meaning. Another significant contribution to research on the CSF concept is the detailed description of the process by which the CSFs were elicited; this also has implications for practice. This technique augments previous approaches outlined by Shank et al. (1985) and Bullen and Rockart (1984), for example.

In sum, this paper has contributed to the cumulative body of research on the CSF concept by highlighting its utility as a fruitful approach for research on the systems development process. What distinguishes the approach described in this paper from others is that the CSFs are presented in context, and the process by which they are arrived at is fully explicated. Previously undocumented interrelationships between CSFs—'generic' and 'collective'—have been illustrated in a network analysis (in Fig. 2) that helps address the reductionism of previous research approaches and other methods of presentation, while at the same time offering practitioners and researchers a rich insight into the phenomenon of study. The paper has also shed new light on process by which information systems are developed by illustrating empirically the process's complex multidimensional nature and by providing fresh insights into the challenges that face developers and users in their task of developing organisational IS. The important lessons for practitioners from this paper is that it is critical to pay attention to such development-related issues as:

- ensuring that there is low level user representation/participation at all stages of the systems development process;
- proper project estimation, planning, tracking to agreed targets, co-ordination and control of project activities;
- obtaining an appropriate level of vendor support;
- spending adequate time on end-user requirements analysis;
- employing prototyping techniques/CASE tools to determine and refine user requirements;

- ensuring that business client/end-user industrial relations (IR)/change management issues related to the ISD process and product are resolved;
- having a committed project sponsor;
- availing of structured development methods and supporting CASE environments;
- overcoming project technical obstacles.

It is clear from the research findings that each of these issues needs to be addressed if information systems are to be developed in line with customer needs and expectations. Nevertheless, one final point worth noting is that when examined out of context the above factors might appear to be superficial; however, if practitioners are aware of the complex web of social conditions and factors that underpin such issues, and give recognition to them in their development policies and project plans, then positive outcomes are likely to follow from development endeavours. In conclusion, then, the two major contributions of this paper are: (1) it highlights the value of the CSF concept and method as a rigorous technique for qualitative research in the IS field; and (2) it illustrates how the concept can be operationalised for both research and practice.

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