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Implementation critical success factors (CSFs) for ERP: Do they contribute to implementation success and post-implementation performance?

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ABSTRACT

Frequent commentaries in the literature have stated that certain critical success factors (CSFs) have to be accomplished in an organisation for an enterprise resource planning (ERP) system project to be successful. In this study we argue and demonstrate empirically that success in implementing an ERP system and in gaining performance improvement should be conceptualised as two separate dependent variables. The distinction is made because the former aspect is based upon project delivery outcomes, while the latter assesses post-ERP project performance. We question whether some factors labelled as 'critical' success factors for ERP projects are in practice actually critical for achieving success in implementation and improving output performance. To examine this we report an empirical study that has investigated whether four major CSFs are in practice critical for achieving organisational performance improvements, and the role that successful implementation may play in influencing the relationship between CSFs and improvements in organisational performance. A conceptual model was devised and then analysed using structural equation modelling based on data collected from 217 organisations. We found that some CSFs were not critical to achieve success in ERP implementation but were critical to help an organisational achieve performance improvement from an ERP system. Additionally, we also found that achieving successful ERP system implementation mediates the degree to which a CSF affects output performance improvement. The managerial and research implications of these findings are discussed and the limitations of the study noted.

1. Introduction

In the 1990s, enterprise resource planning (ERP) systems pioneered a process-oriented business management paradigm. ERP entails gaining knowledge of best business practices and applying these to improve or completely replace existing, legacy practices. The implementation projects of ERP in the 1990s and early 2000s faced challenges such as shortages of experienced project managers and consultants and limited vendor support capability. Today, experienced managers and consultants abound and vendor implementation support protocols are well developed.

However, despite this increased experience and capability, the changes required by ERP have often proven to be overwhelming in many organisations, resulting in ERP project failures (Maguire et al., 2010). The overall failures and implementation difficulties of ERP projects have attracted much research interest (Liu and Seddon, 2009), which has resulted in the accumulation of a substantial body of literature that identifies a large number of CSFs for ERP implementation and overall project success.

However, the continued high failure rates of ERP projects remain a concern (Liu and Seddon, 2009). Table 1 gives a summary of recent ERP problems and failures as evidence of these concerns. This table is drawn from Kimberling (2011) and Ram et al. (2013a) and supports the need for further research to help reduce the failure levels. Several explanations for the continued failures have been proposed. For instance, some researchers suggest that the studies that have identified critical success factors (CSFs) for the implementation process have failed to provide an understanding of how these CSFs for this stage may influence the subsequent performance outcomes of an organisation (El Sawah et al., 2008; Liu and Seddon, 2009). Other scholars even question the usefulness of CSFs (Häkkinen and Hilmola, 2008; Liu and Seddon, 2009).

The current level of knowledge about the role and influence of CSFs and their effects on ERP implementation success and post-implementation performance outcomes is not well established (Finney and Corbett, 2007; Soja and Paliwoda-Pekosz, 2009).

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Table 1
List of ERP project problems/failures.

Organisation name	Year	ERP projects problems and failures
National Health Service (NHS) United Kingdom	2011	After spending about £12 billion (US$18.7 billion), NHS abandoned the project that was aimed at centralising electronic health records of its citizens.
CityTime Payroll System project, New York USA	2011	The project failed due to cost overruns, from budgeted $63 million to an estimated amount of $760 million, and a criminal probe.
Ingram Micro Australia	2011	The problem with SAP implementation at Ingram Micro led to a significant drop in its net income twice in year 2011.
Montclair State University, New Jersey USA	2011	PeopleSoft implementation at Montclair State University faced problems leading to University filing lawsuit against the Oracle for the botched implementation.
ParknPool, USA	2011	The furniture seller company sued Epicor over the failed ERP project.
Marin County, California, USA	2011	Marin County filed a lawsuit against Deloitte Consulting and SAP over a failed ERP project.
Whaley Foodservice Repairs, South Carolina, USA	2011	Epicor was sued by the commercial kitchens equipment company for a project which cost the company more than 5 times the original estimated amount of $190,000.
State of Idaho, USA	2011	Idaho state faced problems due to design defects and other issues that led various payment delays and faulty claims processing after installing a new system provided by Unisys. The state could suffer loss of millions of dollars due to the faulty Medicaid claims.
CareSource Management Group, USA	2011	The group halted the ERP project and sued Lawson that to pay damaged of $1.5million as the software it provided didn't delivered the expected results.
The Victorian Order of Nurses, Nova Scotia, Canada	2011	The implementation of SAP's Payroll system resulted in issuance of faulty paychecks to nurses for at least six months.
Lumber Liquidators	2010	Problems with SAP system were encountered.
Dillard's, Inc.	2010	JDA's i2 implementation failed to meet customer's expectations.
Ferazzoli Imports of New England	2009	Epicor's system did not meet the customer's expectations as promised.

Sources: Kimberling (2011), Ram et al., (2013a)

Grabski and Leech (2007) have shown that the complementarity effects of CSFs on ERP success are important, yet are not well researched. Karimi et al. (2007) have emphasised the need for a better understanding of the effects of CSFs for ERP implementation in order to help organisations plan and execute their ERP projects more successfully.

This study adopted the definition of a CSF as:

for any business, 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 (Rockart, 1979, p. 85).

We argue that a proposed CSF should only be accepted as such when attending to it results in achievement of successful ERP implementation or achievement of improved organisational performance outcomes. We question whether some of the factors that have been identified in the literature as CSFs have been well enough established empirically as contributing to implementation success and/or performance outcome.

We argue that the commonly-used concept of implementation success is usually judged based upon the direct outcomes of the project delivery which includes such measures as completion on time, completion within budget, completion as expected and completion to user satisfaction. The more complete effect of the project should go further than success of project delivery, and hence an overall organisational performance construct is also introduced in this study to measure the post-implementation stage performance outcomes. The organisational performance could include improvements in the operational, financial and customer services dimensions and the creation or enhancement of various long term advantages for the organisation. Therefore, our study proposed the conceptualisation of ERP project success as two separate variables: an immediate 'implementation success' construct and an overall 'organisational performance' construct, with the former occurring first and, perhaps, having a direct affect on the later.

We emphasise that the implementation success and the organisational performance of an ERP system are two distinct concepts and hence should be measured as separate variables in any exercise to understand the effects of CSFs.

The above discussion gives rise to the research questions addressed in this study:

1. Which of some proposed CSFs for ERP implementation are also critical for achieving organisational performance?
2. For these CSFs, is the relationship between them and organisational performance mediated by implementation success?

The investigation of the above research questions is undertaken with the aim of extending knowledge on CSFs and their role in ERP implementation success and ERP output performance improvement. The findings of this study will help practitioners to focus on the salient CSFs for achieving successful outcomes for ERP system projects. To address the research questions we develop a conceptual model and then empirically examine the relationship between specifically chosen CSFs and (a) ERP system implementation success, and (b) organisational performance.

The paper is divided into seven sections. Section 2 presents a review of the literature on ERP implementation, the relationship of CSFs to performance, and the rationale for the selection of the CSFs examined in this study. The research hypotheses and associated conceptual model are developed in Section 3. We describe and detail the methodology that was adopted for the empirical stages of the study in Section 4. The results of the analyses are then presented in Section 5, while Section 6 discusses the findings of the study. Finally, the study's implications, limitations and the proposals for future research are presented in Section 7.

2. Literature review

Given the research questions set for our study, this literature review focuses on the implementation of ERP, post-implementation organisational performance outcomes and the CSFs said to be associated with achieving successful outcome of ERP projects.

2.1. Implementation and post-ERP implementation organisational performance

Borrowing from Cooper and Zmud's (1990) definition of information technology (IT) implementation, we define ERP implementation

as an organisational effort directed towards the installation and diffusion of an ERP system within a user community.

The implementation stage of ERP has been studied from many perspectives and issues. These include identifying CSFs and critical failure factors (CFFs), implementation strategies and approaches, knowledge management, culture, organisational ERP fit, development of models and frameworks to facilitate ERP, strategies, and the post-implementation organisational performance of ERP (Esteves and Bohorquez, 2007). The above list of issues provides a rich basis for the formulation and proposal of many potential CSFs to aid implementation.

Given the capital intensive nature of ERP implementation, a number of studied have examined the impacts of ERP on post-implementation performance outcome. Zhu et al. (2010) found that the quality of implementation and organisational readiness influence post-implementation success. Achievement of the implementation stage of ERP has also been shown to result in benefits and gains for the organisation undertaking the ERP project. The literature has outlined some of these gains that can be realised by an organisation, including:

- Improved coordination (Alsene, 2007);
- Quality check in day-to-day operations and significantly lowered operational costs (Gupta et al., 2004);
- Improved performance across a variety of financial metrics, and higher market valuation (as measured by Tobin's q) (Hitt et al., 2002);
- Reduced inventory costs and a related reduction in the cost of capital (Rikhardsson and Krcmmergaard, 2006);
- Operational performance and continuous learning leading to continuous improvements in performance (Cotteleer and Bendoly, 2006);
- Enhancement in firm competencies of supply chain management through operational process integration and customer relationship interaction (Su and Yang, 2010);
- Efficient use of information leading to profitability (Bendoly et al., 2009); and
- A positive effect on the accounting process through:
  - Increased flexibility in information generation;
  - Increased integration of accounting application;
  - Improved quality of reports; and
  - Improved decision making on timely and reliable accounting information (Spathis and Constantinides, 2004).

We should note that Hitt et al. (2002) observed that organisations can record a reduction in performance and profitability immediately after the completion of the implementation process. However, the reduction appears to be temporary, as organisations tend to achieve performance gains two to three years after ERP implementation (Hunton et al., 2003).

In summary, there is much to be gained from achieving ERP implementation at an operational level, irrespective of any enhancement of final output performance. In Section 2.2 we review research studies that have focused specifically on CSFs and their influence on implementation, so as to provide a basis for the selection of those CSFs used in this study.

2.2. CSFs and their influence on organisational performance

The concept of CSFs emerged in 1961. Rockart (1978) stated that Drucker (1966) influenced the contemporary use of CSFs as a tool to identify management's information needs and strategic priorities. The large body of research identifying CSFs seems to have reached a broad consensus regarding which key factors can have a significant influence on the ERP implementation process. The findings of this research literature are summarised in Table 2.

Although the concept of CSF has been studied in a broad range of contexts, it appears that the role of CSFs in project success and performance outcome has attracted little specific attention. As discussed and defined earlier, a factor can only be termed a CSF if attending to this factor in a satisfactory manner results in performance improvements. Therefore, merely identifying a possibly important factor is not sufficient to constitute a CSF. The problem of establishing whether a CSF is really critical is further compounded by the multidimensional contexts in which 'success' and 'performance' may be measured, such as by user satisfaction or successful completion of a project, or through the tangible and intangible benefits to an organisation.

We find that only a few studies have attempted to investigate the effect of proposed CSFs on implementation success and/or organisational performance improvements. Noticeable examples include Ettlie et al. (2005), whose study found that leadership and business process re-engineering were significant predictors of ERP adoption performance, and Federici (2009), who found that organisational change and vendor support had a positive influence on operational efficiency and economic results, in other words, ERP system output performance.

Grabski and Leech (2007) identified various CSFs that have two-way interactive relationships with implementation success. What has also been found to be critical to managing for overall ERP project success is appointing a full-time project manager, having a project champion and providing training to staff (Bradley, 2008). Other researchers have produced evidence of (a) positive associations between having business vision and external expertise and ERP system success (Ifinedo, 2008), and (b) implementation quality and organisational readiness lead to post-implementation success (Zhu et al., 2010; Motwani et al., 2002). Table 2 summarises the findings on the relationship between CSFs and implementation success and/or performance outputs of ERP. It additionally includes indications of the way that implementation success has been measured in the literature and has, therefore lead to the approach followed in this study.

From the above we conclude that while some research work has been done to understand the influence of CSFs, the output is fragmented and based on a variety of success and performance measures. The output fragmentation leads to difficulties in the consolidation, generalisability and clear understanding of the effect of CSFs on implementation and post-implementation performance outcomes. From consideration of the above discussion and the findings presented in Table 2, we have chosen to examine the effect of four CSFs that have consistently been considered central to implementation success, including those indicated by Dezdar and Sulaiman (2009) and Finney and Corbett (2007). These factors are project management (PM), training and education (TED), business process re-engineering (BPR), and system integration (SI).

The selection of these four factors for this study was based on the literature that has indicated their importance for the success of ERP projects, and has shown that their relationship to success has not been empirically well established. Further, the divergence in measurement of success or performance has resulted in fragmentary understanding of the role of the selected factors in achieving success and performance gains from ERP projects, thus merits further research attention. Except for the TED factor, it is important to note that the other three factors have not been examined previously in terms of their relationship to important success measures of project deliverables related to success of the implementation process, such as being on time, on budget and

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Table 2
List of critical success factors (CSFs) to ERP implementation/performance.

Identified as a CSF to ERP implementation stage	References of studies that have identified the CSF	The studies given below found a positive relationship between the CSF and the implementation success/Performance Implementation success/performance was measured in the studies given below by
Cultural and structural changes/readiness/ organisational culture	Dezdar and Sulaiman (2009); Motwani et al. (2002), (2005)	
Project management and evaluation/project management capabilities	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Snider et al. (2009), Somers and Nelson (2004), Motwani et al. (2002)	– A success index (El Sawah et al., 2008) – implementation quality, which in turn impacts post-implementation success measured by operational and managerial benefits
Business plan and vision,	Al-Mashari et al. (2003), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Nah and Delgado (2006)	– Five dimensions of system quality, information quality, individual impact, workgroup impact, organisational impact (Ifinedo and Nahar, 2009).
Enterprise wide communication/strong communication inwards and outwards/ communication plan	Dezdar and Sulaiman (2009), Finney and Corbett (2007)	
Project champion/sponsor	Dezdar and Sulaiman (2009), Finney and Corbett (2007)	– A three-item measure assessing completion on time, within budget and organisational impact (Bradley, 2008)
BPR and minimum customisation/software configuration/integration of business processes	Al-Mashari et al. (2003), Bingi et al. (1999), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Motwani et al. (2005), Nah and Delgado (2006); Somers and Nelson (2004), Vathanophas (2007)	– A two-item measure that assess impact on business performance and as per expected results (Žabjek et al., 2009)
Training employees/user training and education/ job redesign	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Snider et al. (2009), Vathanophas (2007)	– User satisfaction and ERP benefits (Bradford and Florin, 2003) – A three-item measure assessing completion on time, within budget and organisational impact (Bradley, 2008)
Teamwork and project team composition, competence and compensation/selecting the right employees/balanced team/small internal teams	Bingi et al. (1999), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Plant and Willcocks (2007), Snider et al. (2009), Somers and Nelson (2004)	– A synthetic measure that included scope, duration, financial budget, user satisfaction, and goals achievement (Soja, 2006) – Impact on decision making and control, efficiency and profitability (Wang et al., 2008)
System quality	Dezdar and Sulaiman (2009), Ram et al., (2013b)	– A four-item measure that assess implementation success by: project completion on time/schedule, within budget, as per expectations, and as per user satisfaction (Ram et al., 2013b)
ERP vendor support	Bingi et al. (1999), Dezdar and Sulaiman (2009), Somers and Nelson (2004)	– Impact on decision making and control, efficiency and profitability (Wang et al., 2008)
ERP consultants/consultant quality/use of consultants/qualified consultants	Finney and Corbett (2007), Somers and Nelson (2004), Snider et al. (2009)	– Impact on decision making and control, efficiency and profitability (Wang et al., 2008)
System integration	Al-Mashari et al. (2003), Bingi et al. (1999)	
User involvement, participation and support	Dezdar and Sulaiman (2009)	– Impact on decision making and control, efficiency and profitability (Wang et al., 2008)
Sustained (top) management support/commitment	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Nah and Delgado (2006), Plant and Willcocks (2007), Snider et al. (2009)	– A success index (El Sawah et al., 2008) – Benefits achieved in improved customer satisfaction, planning and inventory management, improved efficiency, know-how and competence, organisational climate (Petroni, 2002).
Interdepartmental (enterprise-wide) cooperation/ communication	Dezdar and Sulaiman (2009), Plant and Willcocks (2007), Somers and Nelson (2004)	
Steering committee	Somers and Nelson (2004)	
Management of expectations	Somers and Nelson (2004)	
Careful package selection	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Somers and Nelson (2004), Vathanophas (2007)	
Data analysis, conversion and integrity	Finney and Corbett (2007), Somers and Nelson (2004)	
Charismatic leadership	Wang et al. (2005)	
Fit between ERP and organisation	Baki and Çakar (2005)	– a success index (El Sawah et al., 2008) – perceived deviation from the expected project goals i.e., cost, time, performance, benefits (Hong and Kim, 2002)
Implementation strategy & time frame	Finney and Corbett (2007)	
Vanilla ERP	Finney and Corbett (2007)	
Build a business case	Finney and Corbett (2007)	
Implementation approach	Vathanophas (2007)	
Organisational transformation and software migration	Vathanophas (2007)	
Formal project plan/schedule	Bingi et al. (1999)	

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meeting user expectations. By conceptually distinguishing the successful implementation and organisational performance as two separate outcomes of ERP projects, we aim to provide empirical evidence of the direct influence of the chosen CSFs on organisational performance and the mediating role of implementation success on the relationship between CSFs and the organisational performance of ERP projects.

3. Research hypotheses

As discussed above, four CSFs were chosen, PM, TED, BPR and SI, to examine their effect on ERP implementation success (IMP) and organisational performance (OP). To facilitate this examination, a conceptual model showing the potential relationships of these four factors to IMP and OP was built and is presented in Fig. 1. The relationships proposed in the model along with their associated research hypotheses are described in the following section.

3.1. Project management (PM)

The inherent complexity of the ERP projects and the high risk of failure necessitate employing formal tools, techniques and methodologies, such as PM methodologies, to improve the chances of project success (Ngai et al., 2008). Project management has been consistently found to be one of the major CSFs for successful implementation of ERP (Ehie and Madsen, 2005; Ngai et al., 2008).

While PM is considered critical to the success of the implementation process of ERP, intuitively its effect will extend beyond that of facilitating increased output value and/or the achievement of the objectives of the project. Successful PM is regarded as having a two-dimensional effect of:

(a) Transforming 'resources into outputs';
(b) Helping achieve project benefits in the form of performance improvements, cost reductions and other desired values established by stakeholders' interests in a particular project (Zhai et al., 2009, p. 100).

Recent research suggests that the effective use of PM practices and techniques – because of their strategic and tactical dimensions – could enable organisations to realise the expected benefits of projects (Shi, 2011). Thomas and Mullaly (2006) claimed that implementation of PM does indeed yield value to organisations; however, its magnitude may vary depending on the project context. The value generated by the use of PM is multidimensional in nature. It is not just limited to monetary returns, but also includes intangible benefits in the form of organisational efficiencies and customer satisfaction (Thomas and Mullaly, 2007; Zhai et al., 2009).

While their research is still preliminary, Jugdev and Mathur (2006) found evidence to suggest that using PM processes, standards, methodologies and techniques – —often termed as 'project management maturity' – can lead to strategic advantage for an organisation. However, organisations must focus both on effectively developing tangible assets (such as PM maturity) and intangible assets (such as sharing know-how) to use PM to gain benefits. The foregoing discussion shows that while some evidence exists – albeit preliminary – for the relationship between PM and OP, further empirical investigations are required to confirm this and help understand the relationship more fully.

Organisations can obtain the benefits of improved performance only if they are able to implement the ERP system successfully (Jiang et al., 2004). Munns and Bjeirmi (1996) noted that IMP is a key mediator and precursor to the achievement of OP. Crawford (2005) suggested that PM competence leads to project performance, which subsequently results in improved OP.

Based on the literature above, we argue that implementation success acts as a mediator between project management and performance outcome. It is an enabler of the achievement of organisational performance and benefits. Consequently, the following hypotheses were developed:

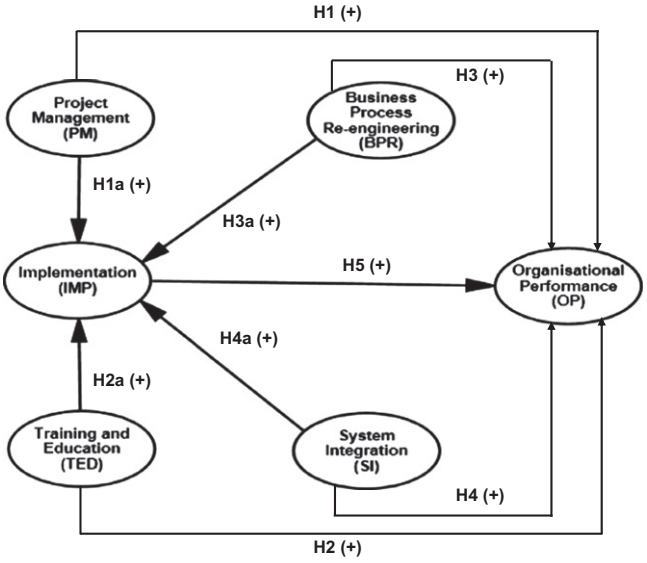

Fig. 1. The research model.

H1: The use of PM for ERP projects is directly and positively associated with OP.
H1a: The influence of the use of PM on OP is mediated by the achievement of IMP.

3.2. Training and education (TED)

Internalizing the knowledge embedded in ERP systems is a most critical strategy for achieving success in ERP projects (Dezdar and Sulaiman, 2009). User education and training serve as a medium to unpack and facilitate the transfer of explicit and tacit knowledge enshrined in the routines, practices and functions of ERP systems. TED is defined here as the continuous transfer of both tacit and explicit knowledge about the logic, concept, processes and function of the ERP systems. Effective training is considered very important to equip users with the necessary skills and tools to use an ERP system efficiently in their day-to-day activities (Stratman and Roth, 2002, p. 612).

A good TED program can help users employ the system to its full potential and can help organisations realise the full benefits of implementing an ERP system (Umble et al., 2003). Tharenou et al. (2007) presented the results of a meta-analysis of 67 general studies that examined the relationship of training to human, organisational and financial performance. They concluded that TED has a positive relationship with OP. In another study, TED was found to be positively associated with user satisfaction, thus leading to improved OP (Dezdar and Ainin, 2011).

A suitable TED program can help organisations ensure effective knowledge management, which has a positive influence on

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management performance for organisations, as measured in terms of financial performance, business performance and organisational effectiveness (Liu, 2011). Effective staff training and education enables organisations to realise financial gains (Jones et al., 2011). In line with the resource-based view (RBV), we argue that training programs that are designed to enhance users' skills are vital to organisational efforts to develop human resource capabilities to achieve the organisation's managerial, financial and performance targets (Khandekar and Sharma, 2005; Tharenou et al., 2007). The knowledge transfer during training sessions produces improved human–system interaction and improved users' confidence, thus resulting in fewer problems in the accomplishment of routine and mission-critical business tasks.

As such, it is logical to hypothesise that a good TED program will result in improved OP. However, for users to be able to employ the system optimally, it is necessary that the system is implemented successfully. A number of studies have found that TED is one of the most important CSFs for ERP implementation success (Dezdar and Sulaiman, 2009; Snider et al., 2009). Therefore, it is reasonable to argue that TED will not only have a direct influence on OP, but that its influence will also be mediated by the success of the implementation.

Based on the above argument, we contend that an effective TED program is expected to improve users' levels of comfort and their expertise and knowledge of the system. It is also expected to influence system success and post-implementation OP outcomes. Thus, this study investigated the following hypotheses:

H2: TED is directly and positively associated with OP.
H2a: The influence of TED on OP is mediated by achieving IMP.

3.3. Business process re-engineering (BPR)

ERP applications embed best business practices, however, these generic processes may not be compatible with the business processes and practices of the adopting organisations. Organisations may thus be required to improve or re-engineer their business processes to align them with an ERP's business model (Lee et al., 2003). BPR is defined as 'the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance such as cost, quality, service, job satisfaction and speed' (Altinkemer et al., 1998, p. 381).

BPR is a strategy to create a conducive platform to facilitate successful ERP implementation. Therefore, it is not surprising that BPR has been found to be a critical factor in the early stages of the ERP implementation process (Ngai et al., 2008). The business process gap between organisational and ERP processes was found to be the likely cause of ERP project failure (Ala'a Hawari and Heeks, 2010). Various authors have found a significant positive relationship between BPR and such factors as ERP overall success, performance improvements, and internal process efficiency benefits (Ettlie et al., 2005; Velcu, 2010). However, the findings of a study by Bradford and Florin (2003) differed from these generally held views, as they found that BPR was not related to ERP implementation success.

Organisations perform BPR to restructure processes to eliminate inefficient and non-value adding operations and to align their ongoing business activities with industry best practices (Shang and Seddon, 2007). BPR has resulted in OP benefits in the areas of finance, customer service and growth sustenance (Devaraj and Kohli, 2000). A business process change was found to correlate with productivity, as measured by sales per employee (Altinkemer et. al., 1998). Grover et al. (1998) claimed that the introduction of information technology must be accompanied by process redesign to gain productivity improvements. Similarly, Devaraj and Kohli (2000) found that IT capital investment should be combined with BPR to achieve profitability. Successful business process changes can be important facilitators to achieve implementation project success and post-implementation performance gains (Guha et al., 1997).

The empirical evidence cited above establishes that performing BPR is expected to significantly improve the chances of ERP IMP and post-implementation OP. Given that a BPR exercise may precede implementation, it is expected that IMP will mediate the relationship between BPR and the realisation of OP improvements. Thus, the following hypotheses were postulated:

H3: Undertaking BPR is directly and positively associated with OP.
H3a: The influence of BPR on OP is mediated by achieving IMP.

3.4. System integration (SI)

On seeking to implement ERP, it is not uncommon for organisations to prefer to retain some existing specialised software packages, either due to unique business needs or regulatory requirements (Bingi et al., 1999). Such a situation necessitates the integration of ERP with these applications. In addition, organisations seek competitive advantage by aligning with other organisations, usually for their non-core business activities, and thus may intend to integrate ERP with partner systems. However, this required integration is a complex process, particularly given ERP's modular structure (Ngai et al., 2008).

Middleware technologies, such as enterprise application integration (EAI), supplement integration requirements (Lee et al., 2003). However, middleware products concentrate on technical interoperability, rather than linking business processes, thus organisations may require further system development activities to build their custom integration interfaces. In addition to the above problems, the cross module integration makes the process more complex (Al-Mashari et al., 2003).

Lee et al. (2003, p. 56) defined the term 'system integration' as 'the capability to integrate a variety of different system functionalities'. Ideally, organisations view ERP as a single solution covering all business functions. Alshawi et al. (2004) proposed that a feasible way to achieve this would be a system that reduces customisation and allows organisations to select the best modules from different vendors and integrate them using EAI. With the ongoing development in integration technologies, cloud computing, software as a service (SaaS) initiatives, and web-based ERP, it is expected that organisations will continue implementing ERP, and will use various integration tools to link their ERP with the business systems and applications external to ERP.

With the implementation of tightly integrated ERP systems, it is expected that organisations will achieve high information visibility and improved decision making across the entire supply chain. Organisations are expected to leverage the integration capabilities of the system to gain better control, improved operations and better cost control, thus leading to improvements in OP (Chapman and Kihn, 2009).

System integration is considered one of the CSFs at the deployment stage of ERP (Al-Mashari et al., 2003). This finding reinforces the importance of ensuring that all the ERP modules are interfaced for the seamless operation of ERP systems, thus allowing successful implementation. It is therefore expected that IMP will mediate the influence of system integration on OP. In consideration of the above arguments, the following hypotheses were proposed:

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H4: SI is directly and positively associated with OP.
H4a: The influence of SI on OP is mediated by achieving IMP.

3.5. Implementation success and organisational performance

An implementation project is considered successful when the implemented systems go live and operate 'with agreed-upon requirements, and delivered within schedule and budget' (Brown and Vessey, 2003, p. 66). Implementation success in the ERP context has been measured from multidimensional perspectives such as, organisational performance improvements, and the completion of the project within the required time, budget and agreed-upon deliverables (see Table 2) (Ke and Wei, 2008).

Shang and Seddon (2002) proposed a framework for managers to assess the benefits of implementing enterprise systems. However, achieving performance benefits depends on the implementation success of ERP projects. Bouwman et al., (2005) proposed that information and communication technology (ICT) innovations in organisations follow a four-stage process: adoption, implementation, use and effects and so support the belief that implementation precedes output performance. Markus and Tanis (2000) and Straub (1994) use such a stage-based approach in their work and indicated that the introduction of innovations into organisations, not unexpectedly, leads to improved organisational performance.

The stage-based modelling approach has been popular for examining innovation in information system, and a number of studies have investigated models with adoption, implementation, use and benefit stages. The ERP literature has been predominantly implementation focused (Haddara and Zach, 2011). The use of CSFs is one of the key implementation strategies employed by organisations to focus on and manage the few key areas in the implementation process that could help achieve a successful implementation outcome. Liu and Seddon (2009) provided evidence that the use of CSFs indeed helps organisations achieve the benefits of using enterprise systems.

In their IS success model, DeLone and McLean (1992) posit that paying attention to key antecedent factors leads to use and user satisfaction of an information system and the realisation of individual and organisational outcomes. However, we note that in the IS success model the antecedent factors directly influence use of the system, once the implementation stage is successfully accomplished. Given the focus of our study is on examining the CSFs' role on the organisational performance directly or mediated through the success of implementation stage, it can be seen that the IS Success model is not fully appropriate for the objectives of our study. But overall, the IS success model supports paying attention to antecedent factors in order to realise individual and organisational outcomes.

Based upon the previous work that supports the sequential, stage-based models of information system by which they enter organisations and can lead to output performance, we argue that organisational performance should be measured as an outcome of the implementation success of ERP. This is supported by Nicolaou (2004, p. 97) who examined the post-ERP implementation performance of 242 firms finding that to achieve implementation success the right antecedents were required. For example, the choice of the right ERP vendor led to post-implementation performance improvements 'as measured by the cost of goods sold as a percent of sales and by the operating return on sales' (Nicolaou, 2004, p. 97).

Given these arguments above, the following hypothesis was proposed:

H5: The IMP of ERP is positively and significantly associated with OP.

4. Research methodology

4.1. Construct operationalisation

We used the measurement items that were operationalised and tested in previous empirical studies and were found to have demonstrated good psychometric properties. These were slightly modified to suit the context of this study. Such an approach is considered to enhance content validity and the comparability and reliability of item measures. Table 3 lists the variables, and details of the measurement items for each variable used in this study. The survey questionnaire used to gather data on these is provided in Appendix A. The variables were measured using reflective items on a five-point Likert-type scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Two item measures were used for BPR and the SI construct. Our overall approach is consistent with several other studies, including those on BPR (e.g., Klein, 2007; Lin, 2006) and those on SI (e.g., Wang and Liao, 2008; Zhu and Kraemer, 2005).

4.2. Data collection

Given the objectives and the nature of the *a priori* relationships proposed in this study, a survey was conducted to collect the necessary data to examine the hypotheses. Australian organisations that have implemented an ERP system were chosen as the population from which to collect data. The sample frame for this study was obtained by purchasing the MarketBase companies database from Fairfax Business Research. This database contains

Table 3
Constructs and item details.

Constructs	Measurement items	References
1. Project management (PM)	6 Items: formal project plan, Project team, regular project status meetings, setting realistic deadlines, schedule & costs monitoring, carefully defined scope	Somers and Nelson (2003)
2. Training and education (TED)	4 Items: adequate length and detail, improved level of understanding of users, build user confidence in new system, knowledgeable and competent trainers	Amoako-Gyampah and Salam (2004)
3. Business process re-engineering (BPR)	2 Items: BPR before ERP configuration, standardisation of business processes	Bradford and Florin (2003), Ehie and Madsen (2005)
4. System integration (SI)	2 Items: integration with legacy systems, and integration with partner organisation systems	Ehie and Madsen (2005)
5. Implementation (IMP)	4 Items: completion on time, within budget, as expected, to user satisfaction	Gottschalk (1999), Hong and Kim (2002)
6. Organisational performance (OP)	7 Items: covering improvements along operational, financial and customer services dimensions	Rai et al., (2006)

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information such as company contact details, chief executive officer/chief information officer contact details, the type of ERP system installed, and company sales figures.

The survey questionnaire asked for information about the implementation experience and the ERP project's outcome. Therefore, senior managers with dedicated involvement in ERP projects were chosen as they were likely to be able to provide a comprehensive evaluation of their organisation's experience of the ERP project and its effects on performance (Wu et al., 2003). Our overall data collection approach was consistent with earlier, similar studies (Somers and Nelson, 2004; Zhu et al., 2010).

The hardcopy and web-based versions of the survey instrument were pre-tested in two phases. The first phase involved obtaining feedback from 15 academics, and nine ERP practitioners participated in the second phase. The feedback gained from the two phases resulted in significant changes and modifications to the format, content, clarity, layout and consistency of presentation for both the web-based version and the hardcopy version.

2002 Australian organisations were invited to participate in the survey by sending them a survey package which included a cover letter, a hardcopy of the survey questionnaire and a reply-paid envelope. With the aim of increasing the response rate, a web-based version of the survey was made available at www.surveymonkey.com.

The survey yielded a data set comprising 217 responses, with 167 respondents declined to participate and 46 survey envelopes were returned undelivered. The net response rate of 12.1 percent was obtained after excluding non-responses: 217/(2002 – 167 – 46). The response rate is typical of such studies (Law and Ngai, 2007a; Velcu, 2010), particularly considering the data was collected from top managers in Australian organisations who receive such requests frequently. The four-page length of the questionnaire (Ifinedo and Nahar, 2009) may also have affected the response rate. After removing eight cases that had not yet adopted and implemented ERP, the study attained 209 usable cases for data analysis.

Descriptive analysis was undertaken to examine the characteristics of the sample and the data generated through the responses. The summarised features of the respondent profile and related data are described in Table 4, in which the respondents' industry type is divided into six groups, organisational size into three groups, ERP type into four groups, and respondents' job title into four groups.

The non-response bias was analysed by comparing early and late respondents, since late respondents were somewhat similar to non-respondents (Armstrong and Overton, 1977; Lahaut et al., 2002). Consistent with other studies (e.g., Velcu, 2010), an independent sample *t*-test was conducted to compare the mean scores of early and late respondents for each of the 25 surveyed variables used in the model, each of which can largely be viewed as continuous. The results of the *t*-test revealed no significant difference ($p > 0.05$) between early and late respondents, except for one of the observed variables (see Appendix B). As this variable (pm6 with $p < 0.05$) constituted a small fraction of the total observed variables (four percent of 25 observed variables), it could be concluded that non-response bias was not a concern. Hence, formal data processing and model estimation and analysis could be performed safely.

The data was examined for common method variance (CMV). The Herman's single factor test is the most widely used approach for detecting the presence of CMV in data (Podsakoff et al., 2003). This test was undertaken by conducting an exploratory factor analysis (EFA) on the data for all the variables (see Appendix C for the EFA results). The results yielded the presence of more than one factor (five factors) and the first factor in the EFA results accounted for 30.72 percent of the total variance of 64.47 percent. Thus, we concluded that the presence of common method bias in the data was very unlikely, and it could be assumed that it would not affect the findings.

Table 4
Demographic analysis of the data sample.

Table 1: Results of the demographic analysis of the data sample

	Frequency	Percent (%)	Cumulative (%)
Type of ERP			
SAP, Oracle, PeopleSoft, JD Edwards	99	45.62	45.62
BAAN, Pronto, QAD, MS Dynamics	42	19.35	64.98
Epicor, Ellipse, Civica, BPCS, SunSystems etc	33	15.21	80.18
Others	43	19.82	100.00
Year of ERP implementation			
2007–2011	43	19.82	19.82
2001–2006	101	46.54	66.36
2000 and before	45	20.74	87.10
Others	28	12.90	100.00
Organisational size			
Large	154	70.97	70.97
Medium	52	23.96	94.93
Others	11	5.07	100.00
Type of industry			
Public sector, utilities, etc.	65	29.95	29.95
Healthcare, pharmaceuticals and miscellaneous	38	17.51	47.47
Manufacturing, mining, automotive	35	16.13	63.59
Higher education & research, professional services	28	12.90	76.50
Wholesale, retail, consumer products	28	12.90	89.40
High-tech, aerospace & defense, telecommunications	23	10.60	100.00
Job title of respondents			
CEO, CFO, COO, MD, GM	56	25.81	25.81
CIO, CTO, IS/IT Mgr, technology director, VP IT	112	51.61	77.42
Business manager, director, DM, FM, PM	32	14.75	92.17
Others	17	7.83	100.00

CEO–chief executive officer, CFO–chief financial officer, CIO–chief information officer, COO–chief operating officer, CTO–chief technology officer, DM–divisional manager, FM–finance manager, GM–general manager, MD–managing director, PM–project manager.

5. Results

5.1. Assessment of the measurement model

The structural equation modelling (SEM) technique using Smart PLS3.0 was used to analyse the data (Ringle, 2013). Partial least square (PLS) – also known as 'components-based SEM' – was chosen because it offers advantages in estimating complex models. PLS is considered less sensitive to violation of assumptions of normality and multi-collinearity issues (Fornell and Bookstein, 1982, p. 443). It allows estimation of models when sample size is relatively small, and the constructs are reflective and/or formative (Chin, 1998; Gefen et al., 2000; Henseler et al., 2009). The quality of the measurement model was validated by assessing the construct reliability, convergent validity and discriminant validity for each of the constructs (Henseler et al., 2009).

Internal consistency of the latent variables was assessed by their composite reliability (CR) values (the term 'latent variable' (LV) and 'construct' are used interchangeably here). CR is preferred over Cronbach's alpha as the measure of internal consistency because Cronbach's alpha tends to underestimate the internal reliability of constructs in PLS path modelling (Henseler et al., 2009, p. 299). The CR values of all the constructs were found to exceed the recommended threshold of 0.7 (Nunnally and Bernstein, 1994), ranging from 0.79 to 0.91 (see Table 5). This indicated that all the constructs demonstrated adequate internal consistency.

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Table 5
Results of the tests of reliability, convergent validity, discriminant validity, and the standardised factor loadings of the variables.

Constructs/latent variables	No. of items	AVE	CR	Correlations (square root of AVEs in the diagonal)					
				BPR	IMP	OP	PM	SI	TED
Business process re-engineering (BPR)	2	0.6850	0.8116	**0.8276**					
Implementation (IMP)	4	0.6421	0.8773	0.1525	**0.8013**				
Organisational performance (OP)	7	0.5765	0.9048	0.1368	0.4237	**0.7592**			
Project management (PM)	6	0.6441	0.9154	0.3045	0.5262	0.2582	**0.8025**		
System integration (SI)	2	0.6635	0.7977	0.2345	0.2886	0.3874	0.3419	**0.8145**	
Training and education (TED)	4	0.7167	0.9098	0.1683	0.5421	0.3986	0.414	0.2609	**0.8465**

The diagonal elements are the square root of average variance extracted (AVE)
CR = composite reliability

Measurement items	Mean	St. dev.	Standardised factor loadings with *p*-values						
			BPR	IMP	OP	PM	SI	TED	*p*-values (2-tailed)
bpr1	0.7054	0.1969	0.7423						< 0.001
bpr2	0.8430	0.2432	0.9050						< 0.001
imp1	0.7353	0.0542		0.7394					< 0.001
imp2	0.7859	0.0430		0.7895					< 0.001
imp3	0.8800	0.0159		0.8819					< 0.001
imp4	0.7867	0.0263		0.7878					< 0.001
op1	0.7568	0.0377			0.7590				< 0.001
op2	0.7893	0.0370			0.7942				< 0.001
op3	0.7303	0.0417			0.7323				< 0.001
op4	0.8020	0.0367			0.8053				< 0.001
op5	0.7073	0.0521			0.7142				< 0.001
op6	0.7893	0.0362			0.7928				< 0.001
op7	0.7069	0.0606			0.7109				< 0.001
pm1	0.7835	0.0452				0.7862			< 0.001
pm2	0.7395	0.0470				0.7435			< 0.001
pm3	0.7883	0.0413				0.7916			< 0.001
pm4	0.7657	0.0370				0.7664			< 0.001
pm5	0.8668	0.0206				0.8677			< 0.001
pm6	0.8529	0.0208				0.8524			< 0.001
si1	0.7988	0.0696					0.8061		< 0.001
si2	0.8185	0.0678					0.8229		< 0.001
ted1	0.8437	0.0255						0.8439	< 0.001
ted2	0.8795	0.0188						0.8804	< 0.001
ted3	0.8883	0.0173						0.8888	< 0.001
ted4	0.7691	0.0366						0.7677	< 0.001

*All standardised factor loadings are significant at $p < 0.001$

Convergent validity – or the extent to which the indicator items underlying a particular construct actually measure one and the same construct (uni-dimensionality) – was examined by the average variance extracted (AVE) value. An AVE value of 0.5 is the recommended cut-off to ensure the construct exhibits adequate convergent validity (Chin, 1998; Fornell and Larcker, 1981). The AVE values for the constructs ranged between 0.57 and 0.71 (see Table 5), thus indicating that all the constructs demonstrated adequate convergent validity. Further, a review of the standardised factor loadings (see Table 5) of the measurement items demonstrated that all the factor loadings were above the recommended threshold of 0.7 and were significant ($p < 0.001$), thus confirming that all the items exhibited adequate convergent validity.

A construct is considered to exhibit discriminant validity 'when it shares more variance with its assigned indicators than with any other latent variable' (Fornell and Larcker, 1981). It is recommended that the AVE value of each LV 'should be higher than the squared correlations with all other latent variables' (Henseler et al., 2009, p. 300). Conversely, the square root value of the AVE of each construct should be greater than its correlation value with all the other constructs. The off-diagonal elements in Table 5 represent the square roots of the AVE's for the constructs. As each off-diagonal value was greater than the corresponding construct's correlation with other constructs in the model, this demonstrates that all the constructs possessed adequate discriminant validity. Having examined the measurement model with the criteria of internal reliability, convergent validity and discriminant validity, it was concluded that the model adequately met the quality criteria.

5.2. Assessment of the structural model

A five-step procedure was used to assess the quality of the structural model. The procedure included assessment of the R^2 value of endogenous LVs, path coefficient values, effect size f^2 values, prediction relevance Q^2 and q^2 values, and goodness-of-fit (*GoF*) values for the model (Henseler et al., 2009; Tenenhaus et al., 2005). The results of the path model are presented in Fig. 2.

The R^2 value of the dependent latent variables of OP and IMP indicated that the four independent LVs – PM, TED, BPR and SI – accounted for 28.7 percent variance in OP, and 40.9 percent variance in IMP. Both the values were adequate and demonstrated a substantially large effect of the four CSFs on OP and IMP. Chin (1998) recommended R^2 values of 0.67, 0.33 or 0.19 for dependent variables as signifying substantial, moderate and weak values, respectively.

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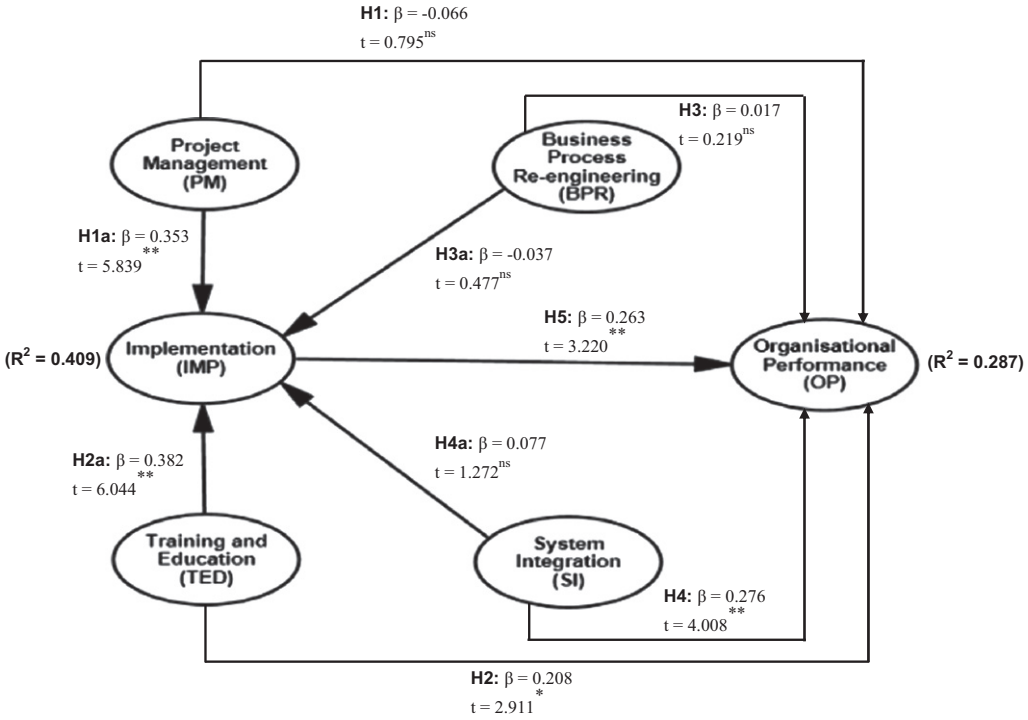
Next we conducted an assessment of the path coefficient values. The LVs, TED (0.208, $p < 0.01$) and SI (0.276, $p < 0.001$) had positive and significant effects on OP. Contrary to the *a priori* assumption, the other two LVs – BPR (0.017, $p > 0.05$) and PM (-0.066, $p > 0.05$) – were not found to significantly influence OP. In addition, the study observed a positive and significant effect of IMP on OP (0.263, $p < 0.001$).

The analysis of the mediation or indirect effect of the four exogenous variables – PM, TED, BPR and SI – on OP yielded interesting results. We see that IMP fully mediates the effect of PM on OP [PM→OP (-0.066, $p > 0.05$), PM→IMP (0.353, $p < 0.001$), and IMP→OP (0.263, $p < 0.001$)]. The effect of TED on OP was partially mediated by IMP [TED→OP (0.208, $p < 0.01$), TED→IMP (0.382, $p < 0.001$), and IMP→OP (0.263, $p < 0.001$)]. BPR was found to have no direct or mediated effect on OP [BPR→OP (0.017, $p > 0.05$), BPR→IMP (-0.037, $p > 0.05$), and IMP→OP (0.263, $p < 0.001$)], and IMP did not mediate the effect of SI on OP [SI→OP (0.276, $p < 0.001$), SI→IMP (0.077, $p > 0.05$), and IMP→OP (0.263, $p < 0.001$)]. Table 6 presents the direct, mediated and total effects.

To further assess the quality of the structural model, the effect size f^2 values of the endogenous LVs were examined. The f^2 values of IMP=0.6935, and OP=0.4091 demonstrated that the exogenous LVs in the model had a large structural effect on the endogenous variables (see Table 7). Further, as the predictive relevance Q^2 values for both the endogenous variables (IMP and OP) were above zero (see Table 7), this demonstrated that the manifesting variables were well constructed (Henseler et al., 2009). An assessment of the q^2 value of the dependent LVs, IMP=0.3109 and OP=0.1858 (see Table 7) demonstrated a medium effect of the structural model on the indicator items for both the dependent LVs in the model (Henseler et al., 2009). To calculate the *GoF* value for the model, this study followed the procedure recommended by Tenenhaus et al. (2005, p. 173). The



Structural paths in the model	Sign	PLS path co-efficient	t-statistic	p-value
H1: Project management (PM) → Organisational Performance (OP)	-	β = -0.066	0.795	ns (p>0.05)
H1a: Project management (PM)→ Implementation (IMP)	+	β = 0.353	5.839	<0.001
H2: Training and education (TED)→ Organisational Performance (OP)	+	β = 0.208	2.911	<0.01
H2a: Training and education (TED)→ Implementation (IMP)	+	β = 0.382	6.044	<0.001
H3: Business process re-engineering (BPR)→ Organisational Performance (OP)	+	β = 0.017	0.219	ns (p>0.05)
H3a: Business process re-engineering (BPR)→ Implementation (IMP)	-	β = -0.037	0.477	ns (p>0.05)
H4: System integration (SI)→ Organisational Performance (OP)	+	β = 0.276	4.008	<0.001
H4a: System integration (SI)→ Implementation (IMP)	+	β = 0.077	1.272	ns (p>0.05)
H5: Implementation success (IMP)→ Organisational Performance (OP)	+	β = 0.263	3.220	<0.001

Hypotheses supported: H1a, H2, H2a, H4, H5
Hypotheses rejected: H1, H3, H3a, H4a
Variance explained: **IMP** = 40.9%, **OP** = 28.7%

**p < 0.001; *p < 0.01; ns = not supported
(two-tailed significance at p<0.05)

Fig. 2. The results of PLS analysis.

GoF value of the model was found to be *GoF*=0.477, which was adequate and demonstrated a large model fit (see Table 7). To conclude, all the five structural model assessments revealed that the research model was significantly reliable and adequately reflected the underlying assumptions.

6. Discussion of findings

The identification of CSFs has remained a dominant research stream in ERP literature. As a result, a large number of CSFs for ERP selection, implementation, use and success have been discussed in the literature. As identified in the review of literature (in Section 2), the role of CSFs in ERP OP and the effects of IMP in achieving OP improvements have not always been conclusively established. This study examined the effect of four major CSFs on OP and the role of IMP as a mediator in influencing OP. We discuss the findings in detail in the following sections.

6.1. Direct and mediated effects of project management (PM) on OP

The finding that PM has no direct effect on OP is understandable. The scope and relevance of the use of PM is mainly limited to the accomplishment of the project's implementation tasks. This study's results are consistent with prior studies that have found preliminary evidence of PM's influence on OP, but not been able to clearly demonstrate the relationship between investments in PM and its contributions to improved organisational performance (Aubry et al., 2007; Thomas and Mullaly, 2007). Thomas and Mullaly (2007) also stated that the evidence of a direct relationship between PM and organisational value remains preliminary and fragmented.

On the other hand, the positive association between PM and IMP confirms that IMP fully mediates the relationship between PM and OP. The results show that effective PM is a predictor of project success because it enhances the potential of achieving OP by minimising the likelihood of implementation failure. Hence, project managers need to pay attention to a number of issues, such as project scope, team formation, monitoring and control (see Appendix A).

Based on the magnitudes of the individual indicators' (standardised) factor loadings on the PM construct (see Table 5, Appendix A), we argue for:

- Strict monitoring of implementation schedule and costs (loading of 0.8677);
- Carefully defined scope of the ERP project (loading of 0.8524); and
- Regular project status meetings (loading of 0.7916).

These are considered the top three key issues to enable effective PM. Project managers should pay attention to these issues to ensure successful implementation of ERP systems. The high values of factor loading for all the six items for the PM construct highlights the need for organisations to use formal PM methods, processes, techniques and standards to achieve IMP, which serves as a precursor to achieving OP.

PMBOK, PRINCE2 and SCRUM are among the many well-known PM models and standards that could be used by organisations to manage their projects. PMBOK is based in the United States. It describes a set of best practices by using a framework comprised of 42 processes to plan, execute and control projects across various industries in most project contexts (Stackpole, 2010). PRINCE2 is a United Kingdom methodology that has a more customer focused and business driven approach to PM.

6.2. Direct and mediated effects of training and education (TED on OP

The finding of a direct relationship between TED and OP is consistent with prior studies (Dezdar and Ainin, 2011; Tharenou et al., 2007). However, the analysis of the data shows that IMP partially mediates the effect of TED on OP. Therefore, the results suggest that TED is not only critical for a successful ERP implementation process, but that its effect goes beyond the

Table 6
Summary of the direct, mediated and total effect of the four CSFs to organisational performance.

Relationships	Results of direct or mediating (indirect) effect of CSFs on organisational performance (OP)	Direct effect β	Mediated effect β	Total effect β	Comments
PM→OP	No (significant) direct effect of PM in OP but (significant) indirect or mediating effect through IMP	−0.066, non-sig	0.092	0.026	Fully mediated
TED→OP	IMP partially mediates the effect of TED in OP.	0.208	0.100	0.308	Partially mediated
BPR→OP	No (significant) direct effect of BPR in OP and no (significant) indirect or mediating effect through IMP.	0.017, non-sig	−0.009, non-sig	0.008	No effect
SI→OP	Direct effect of SI in OP and no (significant) mediating effect through IMP.	0.276	0.020, non-sig	0.296	Direct effect

Table 7
Results of the structural model [effect size (f^2), prediction relevance (Q^2 & q^2), goodness-of-fit (*GoF*)].

Dependent variables	f^2	Q^2	q^2	*GoF*
Implementation (IMP)	0.6935	0.2372	0.3109	
Organisational performance (OP)	0.4091	0.1567	0.1858	
Model				0.477

* f^2 values of 0.02, 0.15, and 0.35 signify small, medium and large effects, respectively (Henseler et al., 2009).
** Q^2 values above zero indicate that observed values are well constructed and that model has predictive relevance (Henseler et al., 2009).
*** q^2 values of 0.02, 0.15, and 0.35 signify small, medium and large effects, respectively (Henseler et al., 2009).
**** *GoF* values of 0.1, 0.25, and 0.36 signify small, medium, large values, respectively (Wetzels et al., 2009).

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implementation process. One possible explanation for this finding is that users obtain the benefits of TED both during and after the implementation process.

The results suggest that the overall success of a TED program could depend on the success of the implementation of ERP, because when the ERP system is operating, it could help users apply the concepts and knowledge acquired through the training programs during real operational circumstances, including the performance of actual business transactions. This explanation seems reasonable, particularly given the complex nature of ERP systems. Users need time to assimilate and internalise knowledge embedded in the functions and features of the ERP systems, and may require prolonged training support to gain an understanding of how best to use the system.

An analysis of factor loadings of indicator items (see Table 5, Appendix A) shows that training programs that are tailored to build users' confidence when using the ERP system (loading of 0.8888), substantially improve the level of understanding of users (loading of 0.8804), and are of adequate length and detail (loading of 0.8439) influence ERP IMP and OP. The foregoing analysis reinforces the importance of careful strategising for the management of TED programs and protocols focused on improving users' knowledge and interaction with the system during and after implementation of ERP systems.

6.3. Direct and mediated effects of business process re-engineering (BPR) on OP

Our study found that BPR has no direct or mediated effect on OP. This finding is consistent with that of Bradford and Florin (2003). While the dependent variable of 'performance' measured in Bradford and Florin's (2003) study differs from the way this study defined the performance variable, the same result was found. They measured performance by considering user satisfaction and ERP benefits.

One potential reason for our finding is that there are other variables that mediate the effect of BPR on OP, such as internal process efficiency improvements (e.g., Velcu, 2010). It is possible that the effect of BPR is captured through other variables, such as the alignment of a business with new systems, or change management (e.g., Grabski and Leech, 2007). However, this presumption is difficult to verify from the results of this study.

That BPR has no direct or mediated effect on OP affects the conceptualisation of BPR as a CSF. While a number of studies have mentioned BPR as a CSF (as discussed in Section 3.3), this study did not find any direct or indirect significant relationship between BPR and IMP, or BPR and OP. Hence, these results call for further examination of the claim that BPR is a CSF in an ERP project context.

Our study's finding that the business process re-engineering CSF is not significantly related to IMP was unexpected, as BPR is often considered a pre-requisite to IMP. However, other researchers have found a significant relationship between business process improvement (BPI) and user satisfaction (Law and Ngai, 2007b), and business process changes and internal process efficiency benefits (Velcu, 2010). Thus, the findings on BPR's role in implementation success remain mixed.

Our unexpected finding could point to two conclusions. First, the result suggests an improvement in learning capacity within organisations. This improvement could be demonstrated by assimilation of knowledge about industry best practices, thereby narrowing the gap between the business processes embedded in the ERP systems and the current business processes of organisations. This might result in lessening the need for business process redesign before configuration of the ERP systems. Second, the finding could indicate the growing maturity of ERP products. ERP products are providing functionalities and features that have better potential to fit well with existing organisational processes, which leads to less need for BPR. Country-specific factors may also be an explanation for this finding. Businesses in developed countries such as Australia may be better prepared to embrace systems such as ERP, due to their contemporary business practices, better infrastructure and better access to information that will assist organisations to be more prepared for ERP. However, this hypothesis would need further study to substantiate it.

6.4. Direct and mediated effects of system engineering (SI) on OP

The analysis of the data shows that SI is significantly and positively related to OP. Prior studies have identified SI as a CSF. However, SI's role in influencing performance outcome has not been studied in earlier research. Therefore, this study has advanced knowledge on the relationship between the accomplishment of SI and OP in the ERP project context. The high value of factor loading (0.8229 in Table 5) for the item 'integration of ERP with partner organisations' information systems' reinforces the importance of focusing on achieving seamless integration between ERP and partner information systems in order to create the business value of an ERP project. Organisations need to establish implementation strategies and systematic guidelines to achieve well integrated and networked systems in order to operate efficiently and competitively.

This finding was not unexpected. It implies that when organisations are able to achieve ERP integration with other systems inside and outside organisational boundaries, this helps them productively conduct business operations. Seamless integration with suppliers could help organisations achieve faster decision making, easier access to information, a reduction in inventory holding and maintenance costs, efficiency in the production process, and a lessening of the average time to market new products. At other times, organisations may need to maintain integration between different systems, for such reasons as particular business requirements, competitive product differentiation needs, or cost considerations.

This study found a non-significant relationship between SI and IMP, thus confirming that IMP does not play a mediation role between SI and OP. The non-significant relationship could be for many reasons. For example, it could be because the SI activities are ongoing, rather than being performed at one point in time. Organisations need to ensure that all the interfaces between different modules of an ERP system are free from error before the systems go live. However, some integration activities – such as interfacing with partner business systems and other in-house systems – would be undertaken after those systems are configured. Thus, it is possible that successful implementation itself influences the accomplishment of SI activities.

Another reason for the non-significant relationship between SI and IMP could be that, with ERP evolution, the problem of ERP connectivity with in-house systems or trading/business partner systems has become less critical. Organisations may be less reliant on in-house or legacy systems, and thus may not require integration with those systems. It could also be that most organisations have already completely replaced or switched off their pre-Y2K systems, and thus SI with their legacy systems is not a major concern. However, with the *best-of-breed* systems gaining some ground (Jones and Young, 2006; Rabaa'i et al., 2009), further examination of the relationship between SI and IMP needs to be undertaken. A further reason for non-significant relationship finding could be a general improvement in integration technologies as a whole, including ERP capabilities that facilitate ease of integration between ERP and other systems.

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7. Conclusions and implications

7.1. Conclusions

Our study's purpose was to investigate the degree to which some major claimed CSFs influence the implementation of ERP systems and the performance improvement from these systems. In order to do this, we argued that the influence of CSFs may be direct or – in the case of output performance improvement – indirect and mediated through implementation. We used structural equation modelling on data from a large sample of companies to examine these possible CSF effects. Explanations for the findings were provided, where they did not conform to the conceptual model. We have also suggested the practical managerial implications of these findings.

We have empirically confirmed that ERP project implementation and ERP output performance improvement are distinct, separate entities and are measurable as such. This finding suggests that managers implementing ERP systems need to clearly identify goals and priorities for these different stages of an ERP project and then devise focused strategies for achieving each of successful implementation and post-implementation OP.

The empirical results confirm that project management (PM) and training and education (TED) are critical success factors for implementation success (IMP) while system integration (SI) and business process re-engineering (BPR) are not. We found that TED and SI directly and significantly influence post-implementation OP. These results indicate that some CSFs can have a dual role in achieving success for an ERP project. A CSF's role may not be limited to ERP implementation, as is commonly understood, but may also influence performance outcomes both directly and indirectly (e.g., TED's influence on IMP and OP).

Our study provided evidence for the mediating role of IMP in facilitating the influence of some CSFs on OP. Such an understanding has important theoretical and managerial implications. Theoretically, this understanding provides a new direction for the way the body of knowledge on CSFs can be further developed. Managerially, the mediating role of IMP demonstrates that achieving ERP implementation can have a double pay-off. First, implementation success is necessary to achieve project delivery objectives and some CSFs help in achieving these objectives. On the other hand, some of the CSFs also need implementation to have been achieved successfully in order for them to be able to effect subsequent organisational performance improvements. So managers should appreciate that some CSFs have more than one effect on the outcome of ERP projects, and management time and resources would be well spent to plan to gain this extra benefit of understanding the locus of impact of CSFs.

The outcomes of our study contribute to knowledge on ERP management by providing new evidence of the direct and indirect influences that CSFs can have on IMP and OP. By using four key CSFs, this study has provided a more holistic understanding of the individual direct and indirect influence these CSFs have on IMP and OP. The results of the study have also demonstrated the combined structural influence these four CSFs exert on IMP ($R^2=0.409$) and OP ($R^2=0.287$). Thus, these results go beyond merely identifying CSFs to that of explaining the role of CSFs and the approach required to manage CSFs at different stages of the ERP deployment process.

7.2. Implications for practice and research

This study's findings have implications for further research into achieving success from ERP projects, and for the successful management of such projects. We show that it is valuable to fully define what ERP project success can mean when seeking to study factors that may influence the success. Our study also shows how the IMP construct can be devised and measured, and how the overall outcome performance from an ERP system can equally be devised and measured. Further, the results of the study confirms that the some major CSFs associated with achieving ERP projects' implementation success are also related to achieving post-implementation organisational performance outcomes, and shows how CSFs can achieve these outcomes.

With this knowledge, managers can make plans regarding which CSFs to focus on for achieving implementation success and which ones are more relevant to achieve organisational performance improvements, when preparing for an ERP project deployment. Knowing that achieving implementation will further enhance the effect of a CSF, such as TED, can guide managers to plan for implementation stage effectively. Our study has shown how the achievement of IMP can mediate the effect of some CSFs on OP. Our findings indicate a potential new direction for future studies on CSFs which is to investigate not only the direct effects of CSFs but also to examine their possible mediated effects to more fully understand how CSFs facilitate ERP project outcomes.

7.3. Limitations

It may be argued that a limitation of our study is that we did not consider the possibility of an intervening variable such as user satisfaction/perceived user satisfaction (Bradley and Lee, 2007) in our analyses, especially in accounting for the effects of TED (Section 6.2). However, the user satisfaction variable is typically measured when the unit of analysis is an individual (see for example, Floropoulos et al., 2010; Kanellou and Spathis, 2013; Wu and Wang, 2007). For our study, the questionnaire responses were asked in relation to the organisation, and so the unit of analysis is at the organisational level. Therefore, to avoid incompatible units of analysis we judged that we could not include perceived user satisfaction/user satisfaction in the study's overall research design.

We do acknowledge that even with the intended unit of analysis being at the organisational level, most questionnaires are completed by individuals who cannot fully eliminate their own expectations and opinions when presenting organisational views while answering the questionnaire. Our research findings are subject to this possible weakness along with many other studies that use a single company source to gain an organisational view. However, the approach we used to formulate our research model is similar to many in the IS literature that do not include user satisfaction constructs, for example, Ifinedo et al. (2010) who explored success measurement without including use and user satisfaction constructs.

An additional limitation in our study is that organisational performance improvement (OP) was assessed by subjective judgments from respondents, not by objective measures such as increased sales of existing products, inventory turnover, new product development, on-time deliveries or reduced lead times. For practical reasons, subjective assessment of performance is common in survey-based research (see for example, Bradford and Florin, 2003; Fuentes-Fuentes et al., 2004; Hsu, 2008). Also, if subjective and objective measures are used in analyses this can add difficulty in evaluating and interpreting the consistency, reliability and discriminant validity of the measures.

It would be possibly more meaningful and preferable to include some objective OP measures in our model so as to more completely reflect the impacts of implementing ERP projects in organisations. However, a number of studies have concluded (see for example, Dess and Robinson, 2006; Fuentes-Fuentes et al., 2004) that subjective measurement of performance is consistent with how an organisation has actually performed. We believe, therefore, that the subjective measurement of OP used in our study, although a

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limitation, may not compromise the worth of our finding concerning OP. We should also note that we have modelled OP as being influenced by IMP and CSFs, but it also could be affected by other factors not included in our study, such as advertising promotions, new distribution channels, R&D or other technological advances, and the general state of the economy.

A further limitation of our research approach is that it is based on data collected at a single point in time through a cross-sectional survey, rather than a longitudinal procedure. Although the structural equation modelling (SEM) analysis offers support for most of the hypothesised relationships, deducing any level of causation from the significant correlation coefficients should be seen in the context of the theory and its underlying theoretical assumptions. The study was undertaken in Australia—a country that has mature IT and resources infrastructure. Therefore, there may be other factors present in countries with less developed, less mature infrastructure, facilities, skills and market size. Seeking to apply the inferences drawn by our study in regard to achieving project success to other types of information systems (other than ERP) should be undertaken with care. Different types of IT system products may require different approaches towards implementation and change management.

7.4. Further research opportunities

An opportunity for future research is to investigate the possible two-way effects that CSFs may have in order to help understand in which direction the effect of CSFs is stronger. Knowing the direction could bring a paradigmatic shift in theories regarding how CSFs have influence and this would contribute to the body of knowledge on CSFs.

We consider that including a two-way relationship between TED and IMP, and SI and IMP, would be useful in future studies on the influence of CSFs. However, the model and analysis of it would be more complex because it would imply that other CSFs also affect TED and SI through their effects on IMP. Introducing perceived user satisfaction as an intervening variable would make the model or analysis even more complex, given that the two-way relationship between TED and IMP exists, and this two-way relationship is also affected by the intervening variable.

We also recommend that future studies should consider extending the research model to include further stages to describe the uptake of ERP such as Adoption and Use and their relevant CSFs. Such a development and extension of the research model could provide a more comprehensive guide to practitioners and organisations when seeking to implement ERP systems. The development of research models that include stages other than just the implementation stage should help further understand the nature, context and the possible impact of the large number of CSFs identified in the ERP literature. Also, the development of the empirically validated model used in our study can help future researchers further the consolidation of the various success models that have been developed in the general information system domain.

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Appendix A. Survey questionnaire

The respondents were asked to indicate their level of agreement with each of the statement on a 5-point scale from Strongly Disgree to Strongly Agree

1. Project management (PM)
   As part of our ERP implementation, we …
   a. had a formal project management plan
   b. had a formal project team
   c. had regular project status meetings
   d. set realistic deadlines
   e. had strict monitoring of implementation schedules and costs
   f. carefully defined the scope of the project

2. Training and education (TED)
   As part of our ERP implementation, the training & education provided within our organisation
   a. was of adequate length and detail
   b. substantially improved the level of users understanding
   c. gave users confidence in the new system
   d. was handled by knowledgeable and competent trainers

3. Business process re-engineering (BPR)
   As part of our ERP implementation, we …
   a. spent lot of time in redesigning business processes before configuring the ERP software
   b. standardised the business processes to the extent possible to fit the ERP system

4. System integration (SI)
   As part of our ERP implementation, we were able to …
   a. integrate ERP with other management information/legacy systems within the organisation
   b. integrate ERP with information systems of partner organisations

5. Implementation (IMP)
   Within our organisation, the ERP …
   a. implementation was completed on time
   b. implementation was completed within budget
   c. implementation was completed as expected
   d. users are satisfied with the implemented system

6. Organisational performance (OP)
   ERP in our organisation has contributed significantly to …
   a. improved product delivery cycle time
   b. improved timeliness of after sales service
   c. improved productivity (e.g., assets, operating costs, labor costs)
   d. increased sales of existing products
   e. finding new revenue streams (e.g., new products, new markets)
   f. establishing strong and continuous relationship with customers
   g. acquiring precise knowledge of customer buying patterns

Appendix B

See appendix Table B1.

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Table B1
Results of the analysis of non-response bias.

		Independent samples test								
		Levene's test for equality of variances		*t*-test for equality of means						
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
									Lower	Upper
bpr1	Equal variances assumed	.785	.377	1.267	207	.207	.17190	.13568	−.09560	.43940
	Equal variances not assumed			1.260	169.951	.209	.17190	.13640	−.09735	.44116
bpr2	Equal variances assumed	.179	.672	.665	207	.507	.08327	.12520	−.16356	.33009
	Equal variances not assumed			.669	176.676	.504	.08327	.12440	−.16224	.32877
ted1	Equal variances assumed	.001	.972	−1.968	207	.050	−.25147	.12775	−.50333	.00039
	Equal variances not assumed			−1.939	164.291	.054	−.25147	.12968	−.50752	.00458
ted2	Equal variances assumed	.868	.353	−1.969	207	.050	−.21851	.11099	−.43733	.00031
	Equal variances not assumed			−1.942	165.047	.054	−.21851	.11252	−.44067	.00365
ted3	Equal variances assumed	.339	.561	−1.358	207	.176	−.16586	.12214	−.40666	.07494
	Equal variances not assumed			−1.346	167.965	.180	−.16586	.12320	−.40908	.07737
ted4	Equal variances assumed	.018	.893	−.749	207	.455	−.08086	.10791	−.29361	.13190
	Equal variances not assumed			−.752	175.161	.453	−.08086	.10751	−.29304	.13133
pm1	Equal variances assumed	.259	.612	−.111	207	.912	−.01215	.10989	−.22881	.20450
	Equal variances not assumed			−.111	173.098	.912	−.01215	.10987	−.22902	.20471
pm2	Equal variances assumed	.001	.971	.639	207	.523	.07105	.11117	−.14812	.29022
	Equal variances not assumed			.641	174.941	.522	.07105	.11080	−.14762	.28972
pm3	Equal variances assumed	.276	.600	.122	207	.903	.01473	.12041	−.22265	.25212
	Equal variances not assumed			.120	163.799	.904	.01473	.12233	−.22681	.25628
pm4	Equal variances assumed	1.595	.208	−1.019	207	.309	−.14687	.14416	−.43107	.13733
	Equal variances not assumed			−1.002	163.435	.318	−.14687	.14654	−.43624	.14249
pm5	Equal variances assumed	2.707	.101	−1.172	207	.243	−.15890	.13559	−.42621	.10841
	Equal variances not assumed			−1.156	165.154	.249	−.15890	.13743	−.43024	.11244
pm6	Equal variances assumed	3.963	.048	−1.003	207	.317	−.14185	.14146	−.42074	.13704
	Equal variances not assumed			−.971	154.410	.333	−.14185	.14607	−.43040	.14671
si1	Equal variances assumed	.486	.486	.177	207	.860	.02131	.12040	−.21606	.25868
	Equal variances not assumed			.179	180.233	.858	.02131	.11889	−.21327	.25590
si2	Equal variances assumed	.149	.700	−1.120	207	.264	−.14392	.12851	−.39728	.10944
	Equal variances not assumed			−1.144	184.893	.254	−.14392	.12582	−.39215	.10431
imp1	Equal variances assumed	1.256	.264	.280	207	.780	.04210	.15037	−.25435	.33856
	Equal variances not assumed			.275	163.137	.783	.04210	.15294	−.25990	.34410
imp2	Equal variances assumed	.528	.468	.845	207	.399	.12154	.14380	−.16196	.40503
	Equal variances not assumed			.855	179.842	.393	.12154	.14209	−.15883	.40191
imp3	Equal variances assumed	.001	.976	.062	207	.950	.00851	.13655	−.26070	.27772
	Equal variances not assumed			.062	172.321	.950	.00851	.13671	−.26134	.27836
imp4	Equal variances assumed	.464	.497	−1.772	207	.078	−.22232	.12545	−.46964	.02500
	Equal variances not assumed			−1.774	173.641	.078	−.22232	.12531	−.46965	.02500
op1	Equal variances assumed	.227	.634	−2.269	207	.024	−.30114	.13274	−.56283	−.03945
	Equal variances not assumed			−2.246	167.111	.026	−.30114	.13409	−.56587	−.03641
op2	Equal variances assumed	2.228	.137	−1.654	207	.100	−.19128	.11563	−.41924	.03668
	Equal variances not assumed			−1.683	182.726	.094	−.19128	.11366	−.41554	.03297
op3	Equal variances assumed	2.489	.116	−1.763	207	.079	−.20121	.11412	−.42620	.02377
	Equal variances not assumed			−1.720	158.633	.087	−.20121	.11698	−.43224	.02982
op4	Equal variances assumed	.013	.909	−.010	207	.992	−.00116	.11234	−.22265	.22032
	Equal variances not assumed			−.010	178.244	.992	−.00116	.11132	−.22084	.21851
op5	Equal variances assumed	.014	.906	−.400	207	.690	−.04401	.11014	−.26116	.17314
	Equal variances not assumed			−.406	181.406	.686	−.04401	.10853	−.25815	.17013
op6	Equal variances assumed	.141	.708	−1.987	207	.048	−.24466	.12314	−.48743	−.00188
	Equal variances not assumed			−1.968	167.366	.051	−.24466	.12434	−.49013	.00082
op7	Equal variances assumed	1.400	.238	−.767	207	.444	−.09574	.12485	−.34189	.15041
	Equal variances not assumed			−.772	176.954	.441	−.09574	.12400	−.34045	.14897

Appendix C

See appendix Table C1.

Table C1
Results of the exploratory factor analysis test.

Total variance explained						
Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)
1	7.679	30.715	30.715	7.679	30.715	30.715
2	3.381	13.522	44.237	3.381	13.522	44.237
3	2.091	8.365	52.603	2.091	8.365	52.603
4	1.733	6.931	59.534	1.733	6.931	59.534
5	1.234	4.937	64.471	1.234	4.937	64.471
6	.998	3.992	68.464			
7	.987	3.949	72.413			
8	.773	3.091	75.504			
9	.696	2.782	78.286			
10	.600	2.399	80.685			
11	.571	2.284	82.969			
12	.507	2.029	84.999			
13	.454	1.818	86.816			
14	.427	1.708	88.524			
15	.389	1.557	90.081			
16	.373	1.492	91.572			
17	.349	1.396	92.969			
18	.283	1.130	94.099			
19	.266	1.064	95.163			
20	.250	1.001	96.164			
21	.237	.949	97.113			
22	.217	.867	97.980			
23	.189	.755	98.735			
24	.183	.733	99.468			
25	.133	.532	100.000			

Extraction method: principal component analysis.

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