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Unpacking the ERP investment decision: an empirical assessment of the benefits and risks

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Abstract

Most leading organizations, in all sectors of industry, commerce and government are dependent upon ERP for their organizational survival. Yet despite the importance of the decision to adopt ERP and its impact on the entire firm's performance the IT literature has been in the large part silent on the nature of the ERP investment decision. This study is the first of its kind to determine the preference structure of senior managers around the organizational benefits and risks of adopting ERP. We present the results which provide interesting insights into how managers' perceive the benefit and risk factors salient to the organization's adoption decision. In line with prior research we found that improved productivity, and information and planning are important drivers of the ERP adoption decision. Moreover our findings reveal that the benefits of ERP are weighted almost twice as important as the risks when making an ERP investment decision. However when it comes to risk, interestingly managers consider issues such as top management commitment and vendor support as more important than financial risks.

Keywords: ERP, Adoption, Decision-making, Discrete Choice Analysis.

1 INTRODUCTION

Studies in the management and IT literatures that have focused on the ERP adoption decision are virtually silent on how managers make their ERP investment decisions, and the strategy making processes that support such decisions. This is despite the fact that ERP investments are generally considered to be a high cost and high risk investment for most firms. Over the past decade, companies have spent over US$300 billion dollars on ERP investments (Carlino and Nelson 2000; Shepherd and Klein 2006), and the failure rate outweighs the success rate (Hong and Kim 2002).

According to a review of published ERP research between 2001-2005, 47 percent of the existing research has focused on the implementation phase (Esteves and Bohorquez, 2007). The critical acquisition phase (or adoption phase) was the second lowest investigated—the lowest being the retirement phase of the ERP lifecycle. Esteves and Bohorquez logically argue that the limited number of studies attempting to investigate how adoption decisions are made in an ERP context is a real problem that needs to be addressed. They agree that the adoption stage is critical because as the stage preceding the implementation phase, it presents the opportunity for both researchers and practitioners to examine the dimensions and implications (benefits, risks, challenges, costs) of buying and implementing ERP software, prior to the commitment of formidable amounts of money, time and resources.

In terms of the strategic decision making process, scholarly effort to measure the process aspects of IT strategy frequently relates to the implementation of strategy or the deployment of resources and capabilities. This orientation tends to emphasize the "doing" rather than the "deciding" aspect of processes. But as Helfat et al. (2008) demonstrate, the processes for making decisions prior to taking action also matter, at least as much as deployment. This point is central to our research approach.

If strategies are made by patterns of decision making as Mintzberg (1973; 1985) suggests then studying the decisions made by senior managers would help to understanding the strategic processes of a firm. This is an idea supported by the strategic process literature which is focused on how firm capabilities can lead to improved organizational performance and competitive advantage. Strategic decisions are viewed as fundamental to firm performance because they can affect the future of the firm through actions taken, resources committed and precedents set (Mintzberg et al. 1976). Priem and Rosenstein (2000) add that "understanding the judgments of strategic leaders is essential to determining (1) how mental processes are manifest in the strategies they develop, and (2) how these processes and strategies affect firm performance" (p2).

Research in strategic management indicates that managers use intuition for key decisions, such as large capital investments (Dane and Pratt 2007), relying on what Hammond (Hammond 1974) describes as the cognitive process of last resort—human judgment. In complex real-world situations, the decision maker often has to rely on something other than facts and a full information when making decisions and resolving problems. Moreover, it is assumed that as the leader of the firm, it is the senior manager's role to make the right judgment.

When it comes to ERP investments, the mixed results reported in industry research highlights the far reaching impact of poor strategic decision making processes (Shepherd and Klein 2006). For instance, in a survey of 232 managers conducted by Robbins-Gioia (2002), 51% of respondents viewed their ERP implementation as unsuccessful. One of the major problems identified was that organizations lacked a rigorous ERP evaluation and procurement process, which in turn, made it difficult to formulate effective investment decisions and avoid a failed ERP investment (Shang and Seddon 2002).

The purpose of this research is to open up the "black box" of managerial decision-making around ERP by measuring the relative importance of the factors that contribute to the decision to invest in an ERP system. To achieve this aim, we will utilize a novel method that will expose the organizational attributes considered to be most important and least important to the investment decision. We will use a utility based approach based on maximum difference scaling or best-worst experimentation. This

method has been successfully applied to many different contexts in order to identify the efficacy of managerial decision making (Buckley et al. 2007), and to provide insights into the preference structures for products and services (Coltman et al. 2007). To address the research issues and provide the focus for this paper we pose two questions:

1. What is the relative importance of the factors that influence the decision to adopt ERP?
2. How do key decision makers' trade-off between the perceived benefits and risks when making an ERP investment decision?

This research draws on two streams of IT literature to determine the factors considered to be most relevant to the ERP adoption decision; (1) the research on the impact of IT, and (2) the specific literature on the organizational impact of ERP adoption and implementation. Whilst a review of the literature provides guidance as to those factors that are likely to drive an ERP adoption decision, there is little evidence regarding the relative importance of these factors to decision makers. This observation was also made by Keil and Tiwana (2006), who suggest that caution should be taken when attempting to hypothesize *apriori* about the factors that have the greatest influence on the ERP investment decision, or the relative weighting that should be given to such factors by a manager charged with responsibility for making ERP adoption decisions.

The lack of past research in this area suggests that this issue may not be a theoretical problem, but rather, an empirical question that should be revealed through appropriate investigation. Furthermore, the IT and ERP impact literature acknowledges that ERP can both positively and negatively impact on organization performance. Yet, surprisingly, the literature has also not considered how both benefit and risk factors influence the decision to adopt ERP. In this study we examine how senior managers value the positive and negative aspects of an ERP investment decision.

2 THEORETICAL BACKGROUND

Studies in managerial cognition demonstrate that executives apply their own mental models to simplify the complex strategic problems they often need to solve (Porac et al. 1989). They use these models as templates to explain and interpret information relevant to decisions they need to make (March and Simon 1958; Walsh 1995). In other words, it is evident in the decision making process that decision outcomes are affected by the way a decision problem is framed. The presentation of a problem or how it is perceived will affect the choices made by the decision maker. This has a dramatic implication for executives, because how an issue is structured can directly impact the investment outcome. Whilst this highlights that managers may be biased in their decision making, using their own judgment to resolve a decision problem, it does not explain the process by which managers filter information in the decision-making process.

Cognitive categorization theory argues that executives, during the awareness and comprehension (learning) stages of decision-making, will group information into categories in order to deal with the abundance of information available and to help them communicate with others about ambiguous strategic issues (Dutton and Jackson, 1987). Executives will then form utility preferences that ultimately form the basis of their strategic choices, in this case the choice to adopt an ERP system.

The filtering of information, which is part of the perceptual process, means that executives can have different perceptions about a problem and form different mental models around a particular decision. Starbuck and Milliken (1988) have identified two types of filtering that may occur: noticing and sense-making. As Tyler and Steensma (1998) suggest these perceptual differences occur because managers *notice* different stimuli and attribute differing meanings to that information, in turn, this will lead to executive's having different mental models around the decision to adopt enterprise systems.

The extant strategic management literature also suggests that threats and opportunities are relevant categories that are often used in strategic planning and environmental scanning activities (Christensen

et.al, 1982). Studies in the strategic decision making field have found that the categories of opportunity and threat are relevant and consequential for decision processes (Mintzberg et al. 1976). The literature on managerial decision making identifies opportunities as a "positive situation in which gain is likely" (Dutton and Jackson 1987). Alternatively, threats are seen as "a negative situation in which loss is likely" (Dutton and Jackson, 1987, p80). Following the work of Tyler and Steensma (1998) we can derive that the organizational benefits achievable through ERP adoption present as opportunities and the potential adoption risks are categorized as threats.

2.1 Benefits and Risks to ERP Adoption.

In an overview of the literature on the organizational benefits of IT, Mirani and Lederer (1998) begin to operationalize and capture the distinctions between benefits. They make an important point regarding the benefits of IT in organizations, which is that any instrument applied to capture organizational level benefits of IT must be tailored to the project being assessed. This fits with Pettigrew's (2003) assertion that strategy research needs to address both the content and context of the phenomena under study.

The framework used for this study to assess the organizational benefits of ERP adoption is derived from the extant literature (Weill and Olson 1989; Sethi and Carraher 1993; Shang and Seddon 2002). The following dimensions, as presented in Table 1, are deemed as important antecedents to the ERP adoption decision.

	Productivity and operations	Competitive advantage	Information and planning	IT Infrastructure	Compliance
(Bakos and Treacy 1986)		✓			
(Broadbent and Weill 1993)				✓	✓
(DeLone and McClean 2004)	✓	✓	✓		
(Gattiker and Goodhue 2004)	✓		✓		
(Hitt et al. 2002)	✓	✓			
(Mahmood and Soon 1991; Sethi and Carraher 1993)	✓	✓	✓		
(Mirani and Lederer 1998)	✓	✓	✓	✓	
(Porter 1985; Miller 1988)		✓			
(Shang and Seddon 2002)	✓	✓	✓	✓	✓
(Tallon et al. 2000)	✓	✓	✓		

Table 1. Key organizational benefit factors

In light of the problems organizations have had with ERP initiatives, it would seem reasonable to assume that risk factors would generate significant research attention. However, the risks around enterprise system investment are not well developed in the literature with most of the scholarly attention being directed towards the benefits. Esteves and Bohorquez (2007) concur and state that most of the studies that do focus on risk are case-based, exploratory studies and lack a strong theoretical basis.

The risk dimensions used in this study represent a synthesis of the major risk factors from the IT and ERP impact literature. This also includes work that has focused on critical success factors, because they are dimensions that if ignored can be detrimental to the success of the investment. These dimensions, along with the associated research are presented in Table 2.

Whilst prior research outlines the importance of both benefit and risks in terms of their impact on an organization there is a lack of research that considers exactly how these factors interact to influence the decision to adopt an ERP system. For example no research could be found to determine whether

cost is more important to a manager deciding to invest in ERP than vendor support or whether productivity and operations is more important to a manager deciding to invest in ERP than management commitment.

	Internal Productivity	Cost	Vendor support	Management commitment	Human resources
(Eisenhardt and Zbaracki 1992; Besson and Rowe 2001)	✓				✓
(Chau 1995)		✓			✓
(Gupta 2000)		✓		✓	
(Somers and Nelson 2001)	✓		✓	✓	
(Themistocleous and Irani 2001)	✓				
(Stratman and Roth 2002)	✓			✓	
(Umble et al. 2003)	✓		✓		
(Beard and Sumner 2004)	✓	✓		✓	✓
(Gattiker and Goodhue 2004)	✓				
(Gargeya and Brady 2005)				✓	
(Keil and Tiwana 2006)		✓	✓		

Table 2. Key organizational risk factors

3 METHODOLOGY

An effective method for evaluating the issues impacting on the adoption of a new information system (such as those related to an ERP investment decision) is to model preferences as a response to experimentally designed decision profiles. This approach, commonly known as probabilistic discrete choice analysis (DCA), has been used to model choice preferences of decision makers in a variety of organizational areas spanning marketing, operations management, transportation and economics (e.g., Verma et al. 2006).

The statistical model underpinning DCA draws on Thurstone's (1927) original propositions in *Random Utility Theory* to provide a well-tested theory of human decision making that has been generalized by McFadden (1974). This theory allows scholars to conceptualize individual choice as a process of decision rules (Louviere et al 2000). When selecting any product, service, or combination of both, a customer will consciously or unconsciously compare alternatives and make a decision that involves tradeoffs of the components of those choices. The result of this process is a choice outcome that can be decomposed based on the options available within some underlying experimental design.

3.1 Best-worst Scaling

There are a number of different DCA methods that allow a researcher to elicit stated preferences that can be used as a basis of understanding and predicting actual behavior *in the marketplace*. One relatively simple method particularly useful in narrowing down and getting a quick snapshot of preferences is best-worst scaling. The formal statistical proofs and the measurement properties for best-worst scaling can be found in Marley and Louviere (2005). Fundamentally, best-worst scaling is an ordering task that requires respondents to make a selection from a group of items and choose the 'best' (most preferred) and 'worst' (least preferred) items in a series of blocks of N>2 items. The items could be attributes of a product, factors influencing a decision, or bundles of services and products. The approach is particularly effective in creating a preference ordering for the items when the number of items is large, as individuals are better able to determine which 2 of group of items are 'best' and 'worst' than they are the specific ordering of 1, 2, …, 12, 13. Best-worst scaling has the added benefit

that it is quick and simple to execute, provides results that are empirically consistent with more complex ordering tasks and theoretically in line with the precepts of random utility theory.

The cognitive process undertaken in the selection of the *best-worst* or *least-most* important items is statistically equivalent to:

- Identifying every possible pair of items available;
- Calculating the difference in utility between the two items in every pair; and
- Choosing the pair that maximizes the difference in utility between them.

Thus, the pair of items chosen maximizes the difference in the marginal utilities on offer between each of the various items in each block of items presented to the decision maker. Empirically, the distance between items is modeled as a difference where the relative ordering of the items is proportional to the number of times it is mentioned *best* less the number of times it is mentioned *worst* (Szeinbach et al. 1999).

In this study, we use best-worst scaling to determine the relative importance of the factors influencing the ERP adoption decision. This allows us to reduce a list of factors associated with the ERP adoption decision down to a manageable number of important components that can be scrutinized in more detail. In particular, we can use the resulting scale to make direct comparisons based on the preference for one factor versus any other factor in the original list.

3.2 Operational measures and survey construction

Preliminary research captured a wide range of factors that are important to the decision to adopt ERP. The factors selected in our study were based on an extensive review of the academic literature and two rounds of qualitative fieldwork. The literature review resulted in the identification of 10 factors that influence the ERP investment decision (see Tables 1 and 2). This list was then validated with a sample of IT managers using semi-structured interviews based on the laddered technique (see Reynolds and Gutman, 1988). This qualitative technique used means-end theory and probing to reveal a salient list of factors that either positively or negatively influence the ERP investment decision. The findings of these interviews helped us to recognize that business growth was an omitted driver of ERP investment, and that the cost factor needed to be separated to recognize the impact of actual versus opportunity costs, where the actual costs were further dissected to reflect differences between the initial investment and ongoing running costs. This increased our original list to 13 (see Appendix 1). While we acknowledge that this list is not exhaustive, we do believe the rigour of the above process does ensure that the list is representative.

As a final stage, and in line with the recommendations of Rossiter (2002), a second round of interviews was conducted with a sample of academic experts to validate the definitions and classifications of the 13 factors. The goal of this second qualitative phase was to ensure that each factor was concrete-singular. That is, we wanted to make sure that each factor had a common meaning across the respondent group. To do this, each expert provided qualitative feedback on the focus and purpose of the factor definitions. The construct definitions and labels were subsequently revised until all experts agreed on the definitions and the classification of the factor as either positively or negatively influencing the ERP investment decision.

Respondents were required to examine 13 sets of four factors. Within each set they were asked to indicate which factor they considered to be *the most important*, *the next most important* or *the least important* when investing in ERP (see Table 3). A balanced and incomplete block design was used to determine which factors appeared in which set, and to ensure that each factor appeared an equal number of times and at least once with all other factors (Street and Burgess 2004). The experimental designs that support this analysis also mean that we can obtain more data from each respondent. This in turn, increases the effective sample size, and allows us to obtain reliable estimates of demand preferences with smaller samples. This is a key advantage of DCA methods that is derived from assumptions regarding the independence of individual choices and the distribution and variance of measurement errors (for a more detailed explanation, see Louviere et al. 2000).

Which factor matters MOST?	Set of factors for you to consider…	Which factor matters LEAST?
○	Low maintenance cost	○
○	Improved IT infrastructure	○
○	Adequate human resources	○
○	Better compliance	○

Table 3. Example best-worst question.

4 ANALYSIS AND RESULTS

Fifty-seven middle-to-senior managers completed the best-worst experiment. The distribution of respondents by industry and occupation is shown in Table 4. In all cases the respondents were key decision makers that were involved in the evaluation of an ERP investment. Two industries dominated our sample, manufacturing and services, with the respondent roles including directors (CEO, GM) and IT executives (CIO, CTO and IS managers).

Respondent Industry	%	Respondent Occupation	%
Manufacturing	32	Director	32
Service	28	IT Executive	24
Public Administration	9	Finance Executive	12
Construction	9	Vice President	9
Wholesale	5	Sales	3
Mining	3	Services	2
Retail	3	Consultant	2
Transport	2	Business Analyst	2
Other	9	Other	14

Table 4. Sample profile

Factors	Best	Worst	B-W	Weighted Best	Weighted Worst	Ratio scale	Rank
Productivity & operations	155	12	143	1252	251	2.23	1
Information & planning quality	106	15	91	863	226	1.95	2
Business growth	93	43	50	787	437	1.34	3
Management commitment	57	34	23	490	329	1.22	4
Competitive advantage	72	76	-4	652	680	0.98	5
Vendor support	31	44	-13	292	383	0.87	6
IT infrastructure	30	53	-23	293	454	0.80	7
Human resources	33	59	-26	323	505	0.80	8
Compliance	42	78	-36	414	666	0.79	9
Acquisition cost	35	76	-41	356	643	0.74	10
Maintenance cost	34	76	-42	348	642	0.73	11
Internal productivity	20	71	-51	231	588	0.63	12
Opportunity cost	19	89	-70	241	731	0.57	13

Table 5. Ranking of ERP decision factors

The best and worst frequency score were calculated for each of the 13 attributes according to the number of times the attribute was selected by respondents. The simple rank ordering process creates individual-level scales for each attribute that are easily comparable across the entire sample (see Table 5). The "best" column illustrates the frequency that the particular attribute was ranked "best" or matters "most" to respondents from the group of factors. For example, the top-scoring attribute was

productivity and operations (selected 155 times), followed by *information and planning quality* (selected 106 times) through to *opportunity cost* (selected only 19 times).

The "worst" column shows the frequency with which respondents selected an attribute as the "least" important feature. To determine the rank ordering for the factors we created a best-worst ratio scale. This scale provides a relative rank for each factor compared to every other factor. To develop the ratio scale of "best" we calculated the square root (SQRT) of the weighted best/weighted worst based on Luce and Suppes (1965) ranking theorem and the mathematical proofs provided by Marley and Louviere (2005).

The interpretation of Figure 1 requires some discussion because the scores are on a relative scale. This means that *information and planning* (2.23) is two times more important than *competitive advantage* (0.97) and four times more important than *opportunity cost* (0.57). Likewise, *information and planning* (1.95) is more than twice as important as *human resources* (0.80), *compliance* (0.79) and *acquisition cost* (0.74). In general, we see that ERP benefits outweighed the risks when it comes to making an ERP investment, with four of the top five ranked factors drawn from the list of potential investment benefits. Another effective way to evaluate how key decision makers trade-off between the perceived benefits and risks when making an ERP investment decision, is to compare the average B-W ratio score for the two groups of factors. Using the classifications shown in Appendix 1, we see that the benefit factors had an average B-W ratio score of 1.35 compared to just 0.80 for the risk factors. Stated simply, this finding reveals that benefits of ERP are weighted more than one and a half times more important as the risks when making an ERP investment decision.

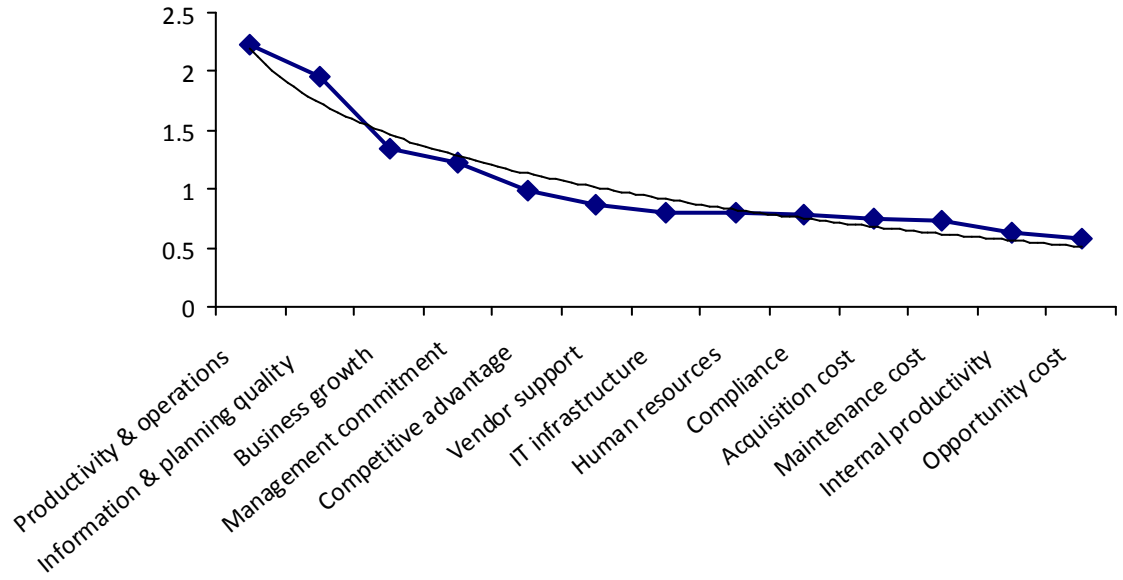

Figure 1. Plot of B-W Ratio Scale

5 DISCUSSION

The results of this study highlight some interesting findings. Our study supports prior research on the impact of IT in the organization which suggests *productivity and operational improvements* remain important to organizations investing in ERP technologies. Numerous studies on IT impact and adoption report that operational and productivity improvements are a key driver of ERP adoption decisions (Mirani and Lederer 1998; Tallon et al. 2000; Shang and Seddon 2002; Gattiker and Goodhue 2004). Based on the *theory of production*, ERP adds value by increasing output whilst reducing costs, through the automation of production processes (Shang and Seddon 2002). For example, several previous studies have found that organisations that have invested in ERP lowered

inventories, shortened delivery cycles and had shorter financial closing cycles, which lead to an overall reduction in costs (Beard and Sumner 2004). In fact, productivity and operational improvements have long been considered as a central source of IT value.

We also report that improved *information and planning* has a positive influence on ERP adoption, given its ranking as the second most important factor. Access to accurate and timely information is a major source of value stemming from the adoption of ERP. The improvement of coordination amongst functional areas is central in supporting organisational processes and decision making (Sethi and Carraher 1993; Tallon et al. 2000). The reporting functions of ERP enable faster retrieval of information formatted in a concise manner, thus allowing more control over organisational performance. This means that ERP is ideally positioned to provide decision and planning benefits through the use of centralised databases with built in analysis and business intelligence tools (Shang and Seddon, 2002).

Perhaps surprisingly, financial risks (*acquisition cost, maintenance cost and opportunity cost*), whilst being dominant factors in the literature around technology adoption and implementation, make up three of the four least important factors to the ERP adoption decision. When considered against the numerous other decision factors, cost based risks appear less important than prior research has led us to believe. For example, it has been observed that organisations cited such risks as a major deciding factor in their ERP purchase decision (Chau 1995; Gupta 2000; Keil and Tiwana 2006).

It is also interesting to note that the first risk factor deemed most important is *management commitment*, not financial risk. This finding could partly be attributed to the industry press around large ERP failures and past business experience. These reports have made managers increasingly aware of performance around ERP initiatives. We found that having the commitment of management was seen as almost two times more important than, gaining competitive advantage and was on par with creating business growth and information and planning improvements. Without commitment from managers to support strategic IT projects; in terms of resources, including buy-in from the business; the prospect of an ERP project is much less certain. In terms of the strategic management literature, the deterministic perspective suggests that managers are the key drivers of successful strategic initiatives.

Furthermore, the emphasis on benefits vis-à-vis risks in the ERP evaluation process could also provide valuable insight into why so many ERP investments fail. Drawing on the work of Kahneman and Tversky (1972), the findings of this study suggest that managers may be over optimistic about the performance and productivity rewards that may flow from an ERP investment, and subsequently marginalising or even ignoring the inherent risks. Interestingly, this would make ERP consistent with other past emergent technologies, where history has consistently demonstrated that even experts suffer from optimism bias when espousing the future benefits of new technologies (Avison and Nettler 1976).

5.1 Limitations and Future work

Much of our understanding of ERP has been shaped by interviews, case studies and industry surveys (Besson and Rowe 2001; Shang and Seddon 2002; Beard and Sumner 2004; Gargeya and Brady 2005). The few quantitative studies undertaken have essentially focused on single cases or limited sets of adoption antecedents (Hitt et al. 2002; Keil and Tiwana 2006). Whilst prior research and industry evidence has been able to tell us which factors are important, it has not determined the order of importance of these factors to the ERP adoption decision, or the relative importance of benefits vis-à-vis risks. This kind of information would surely be invaluable not only for academics studying enterprise system adoption, and for practioners trying to make effective investment decisions, but also for ERP vendors trying to develop products that better match the preferences of their customers.

This research is the first to consider the relative importance of the organizational impact factors on the ERP adoption decision of senior managers. Moreover, the study has combined both benefit and risk factors to obtain a more realistic view of how senior managers evaluate the factors that influence an

ERP investment decision. By applying the best-worst method, we add to a growing body of research that suggests that such methods are less cognitively demanding and more accurate in their estimation of preference. Furthermore the method applied in this study overcomes the inherent problems of scale bias and other scale issues (such as how to interpret individual ratings on a traditional scale). Future work can extend on this study by examining the impact of external factors on the preference structure and ERP adoption choice, or by replicating this research in different contexts and with different decision making factors.

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Appendix 1. Factor definition and classification

Factor	Definition
Acquisition cost (R)	The total cost of acquiring the initial package (site license).
Business growth (B)	Increased business growth- the technology provides support for increased business growth
Competitive advantage (B)	Competitive advantage is created by differentiating core competencies from competitors e.g. Creating a differentiated product or service offering
Compliance (B)	The technology increases the organisation's ability to 'stay on track' by creating internal controls and structures to ensure conformance to regulations, legal procedures and standards.
Human resources (R)	The organisation has an adequate level of expertise needed to implement and maintain ERP in-house or has access to external expertise via a consultant or third party service provider.
Internal productivity (R)	There will be no loss of productivity when the system goes live.
Information and planning quality (B)	Quality of information (accuracy, reliability and timeliness) is improved resulting in efficient and effective decision making and planning across the enterprise.
IT infrastructure (B)	Improved base infrastructure which will allow future application investments to be less costly and more efficient.
Maintenance cost (R)	The annual cost associated with the operation of the system.
Management commitment (R)	Complete commitment exists from managers, to provide organizational resources to support the investment.
Opportunity cost (R)	The cost of ERP in terms of the opportunity forgone to invest in other capital.
Productivity and operations (B)	Productivity is increased and operational costs decreased, through automation and standardisation of business processes
Vendor support (R)	The technology is supported for at least 5 years and the level of support provided by the vendor is substantial.

Legend: B = benefit factor, R = risk factor.