lAn evaluation on the use of ERP system in a tertiary education institution in Australia: lessons learned

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Abstract. This paper evaluates the use of Enterprise Resource Planning (ERP) system in a tertiary education institution in Australia and the implementation of the human-centered on the ERP system. The objective of the paper is to learn and measure a hierarchical influence of five human-centered dimensions on user satisfaction both directly and indirectly. This paper attempts to provide answers to whether the human-centered measurement models provide a systematic evaluation of ERP. The contributions of the paper to knowledge are to establish the need for the human-centered approach as a basis for the design of ERP systems, to define a systematic hierarchical human-centered model for measurement, in particular, and accounting information systems, in general, and to develop methodology for validation of the measurement model and applies it to evaluation of ERP systems. This paper suggests the application of a proposed five dimensional model in measuring the human-centeredness of ERP systems using hierarchical model and looks at the implementation in a university context.

Keywords*: Accounting information systems, enterprise resource planning systems, hierarchical human-centered system, information system success, university context, user satisfaction*

JEL codes*:*

Introduction

Enterprise Resource Planning (ERP) is regarded as the most effective computer application to support the overall business objectives regardless of the constraint from hardware, software and human resource (Ng et al.,1998). However, it is not guaranteed to adopt ERP with success. One of the major reasons to confront failure is inappropriate use of design and implementation methodology of ERP. Yoon et al (2011) addressed the integration of business functions and processes requires seamless information integration and decision making. Huang (2002) highlighted the gap between high level planning and low level operation in ERP design. Moreover, ERP is defined as an industry term for a broad set of activities supported by multi-module application software that helps organizations manage

their critical business processes, including product planning, procurement, inventory management, interacting with suppliers, providing customer service, and tracking orders (Olson, 2004). ERP system is one of the most significant technological advances to emerge during the last decade (Chung et al., 2008).

Most software projects are largely undertaken with a focus on developing successful products rather than successful systems (Khosla et al, 2000). These successful products, which range from Microsoft Office tools like Access and FrontPage to more sophisticated packages known as ERP like SAP (Systems, Applications and Products in Data Processing), Oracle, JD Edwards, PeopleSoft and Baan, are efficiency and cost-driven. These products are mass produced, and they are developed in isolation from other system components like people, information and existing technologies and existing business processor work activity. In other words, these products are designed and developed in the absence of direct involvement and active participation of the end users especially at the early ERP implementation stages such as initiative, evaluation and selection stages suggested by Mäkipää (2003). Invariably, these products also lead to a 'guru' culture in organisations (Hoffman et al, 2004).

Existing research on usability of ERP products has indicated that they are not designed to strongly collaborate with its users. Cooprider et al (2010) have developed a conceptual model of collaboration with properties cooperative activity being described as commitment to a joint activity, mutual responsiveness, and commitment to mutual support, and explain why such collaboration can improve usability of ERP system. However, their work is more focussed on the conceptual level and the empirical work is not comprehensive. Singh and Wesson (2009) used a set of heuristics as evaluation criteria for studying the usability of ERP system. Kanellou & Spathis (2011) have collected empirical evidence which confirms a number of accounting benefits derived from ERP system particularly for accounting process. Their work is limited to user satisfaction in the accounting business function and does not cover users at the enterprise level.

Tertiary education institution in the 21st century is facing the emergence of a new reality where almost every human activity may be intimately affected, supported, monitored and sometimes even controlled by, the ubiquitous computer and communication technology such as ERP. This suggests an urgent and immediate need to develop scientific and engineering methodologies (methods, solutions, frameworks) for designing, building, and analysing complex systems that centre on fundamental forms of human activity supported by computer and communication technology.

This paper applies a comprehensive human-centered approach in studying the design of ERP system against technology-centered approach based on five dimensions. It analyses how this sophisticated ERP system can better assist its user to carry out various business processes and raise user satisfaction. This paper is consistent with the concept of a successful system addressed by Khosla et al (2000), discusses model in measuring the human-centered design of the ERP system which lead to increasing user satisfaction.

This paper undertakes a case study in the implementation of SAP-ERP system in an Australian university context. It involves employees who work for a university to assess the ERP system implementation based on their experiences while using SAP to perform their work. The objective of the paper is to learn and measure a hierarchical influence of five human-centered dimensions(process, syntactic, semantic, social and pragmatic) on user satisfaction both directly and

indirectly. The authors believe that the human-centered approach employs a holistic method in measuring the human-centeredness in terms of three criteria: *(i) problem centered; (ii) activity-centered;* and *(iii) context centered*. The paper also develops methodology for validation of the measurement model and applies it to evaluation of user satisfaction of ERP system.

The next section introduces theoretical underpinning and establishes hypothesis, followed by the research methodology (which includes data collection and model development), research outcomes and conclusions.

Theoretical Underpinning and Hypothesis Development

Several studies have addressed a need to design the ERP carefully to fulfil strategic business goals better (Ng et al, 1998; Yoon et al, 2011; Huang, 2002). Particularly, ERP system is fundamentally bound up with the work of accounting, and has been seen to have transformative implications for the nature of organisational integration and control (Chapman, 2005). A number of researchers (e.g., Bashein et al., 1997; Cooper & Kaplan, 1998; Sotto, 1997) believe that early contributions in the accounting literature frequently took the form of introductions to the 'new' technology, coupled with speculations on its implication for accounting, accountants, and management control.

ERP system and Technology-Centered Approach

The history of technology-centered approach can be traced back to the Chicago World fair (1933). The motto of the Chicago World fair was "Science Finds, Industry Applies and Man Conforms". In other words, science invents new technologies, industry applies them for solving various problems and people or users are expected to comply with the nuances of the technology.

The conceptualisation of a problem domain in the technology-centered approach is largely on system designer's perspective rather than the user's perspective (Khosla et al, 2000). ERP system is a product of technology centered. It is developed based on the system designer perspective.

Traditionally, in machine-centered or product/technology-driven design, including computerised systems, the technology or process is designed to simplify what the machine must do, and people are expected to adjust to the machine's weaknesses and limitations. An assumption within this tradition is that technology users will read and understand manuals, regardless of how arbitrary and illogical a system may seem. On the other hand, in human-centered design, the technology or business process is designed to make the participants' work as effective and satisfying as possible (Alter, 2002).

ERP system required the organisation to adapt to the software rather than modifying the software to suit the organisation's established practices. However, this is no longer a common case. Kumar et al (2003) note that implementation challenges relate more too behavioural and management issues than to technical difficulties. Somers and Nelson (2001) have listed 22 Critical Success Factors (CSFs) for ERP implementations where eight of the top ten CSFs are related to human factors in the implementation process: top management support, project team competence, interdepartmental cooperation, clear goals and objectives, project management, interdepartmental communication, management of expectations, and careful package selection. The implementation approach can be affected by those

who are closely involved in the design of company's ERP implementation (Vilpola and Väänänen-Vainio-Mattila, 2005). Skok and Legge (2002) have illustrated the complexity of the relationships amongst the stakeholders by depicting persons representing different stakeholders their thoughts, and possible conflict points in the interaction between them.

Where the organisation can successfully adapt to the software, significant gains in productivity, speed of reaction, streamlined data flows and direct access to real-time operating information may be achieved. If the organisation fails to address this imperative, or its strategy does not suit the generic ERP solution, then such operating and management benefits can be elusive (Davenport, 1998; Scapens et al., 1998).

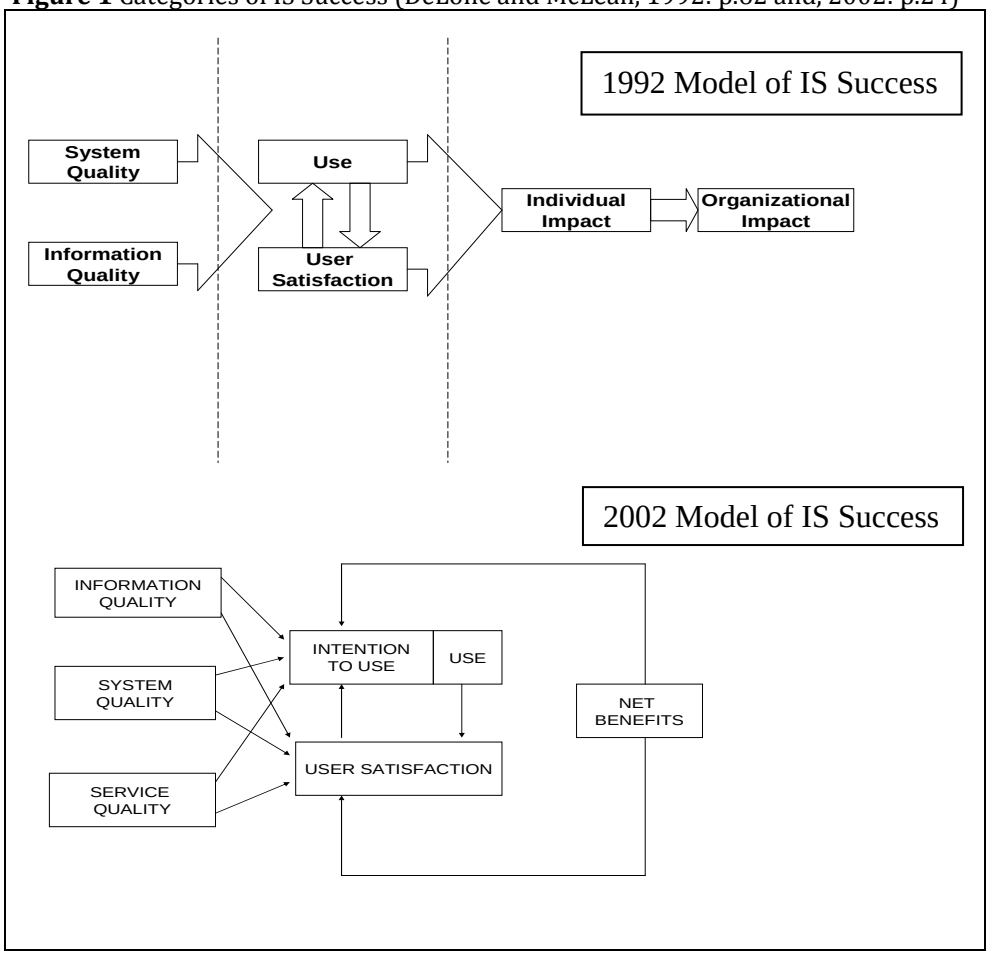
ERP system and Human-Centered Approach

The notion of involving the human-centered dimensions is to provide more comprehensive models and analysis on the implementation success of ERP system. Three models invented in three different decades by Shannon and Weaver in 1948, by Mason in 1978 and by DeLone and McLean in 1992 and in 2002 have inspired the authors to create and examine a set of measurement for implementation success of ERP system. Shannon and Weaver model involves technical, semantic and effectiveness or influence levels in measuring IS success. Mason model adopts five elements of IS success namely production, product, receipt, influence on recipient and influence on system. The two DeLone and McLean models of 1992 and 2002 are shown in Figure 1.

It is interesting to learn how current concepts have evolved from Shannon and Weaver in 1949, Mason in 1978, and finally DeLone and McLean in 1992 and 2002. The research works of Shannon and Weaver, and Mason are heading in the same broad – achieving IS success through conveying information and influence to the recipient or user. However, research by DeLone and McLean provides more insights in the efforts of creating measures for IS success. The existing theories such as the unified theory of acceptance and use of technology or UTAUT (Venkatesh et al, 2003) and the technology acceptance theory or TAM (Davis, 1986; Davis, 1989) are largely limited to the behavioural intention to use and the usability (usage) interface analysis of ERP system. These existing theories and research do not include a systematic human-centered analysis of the ERP system in terms of process, syntactic, semantic, social and pragmatic quality.

Human-centered systems involve people who are using technology to solve problems. To serve a wide population such human-centered system must be universally available and adaptable to the needs of members of the diverse communities found in any country. They vary demographically from young to old, they speak various languages, and an increasing fraction has limited mobility, eyesight, and hearing (Lesk and Wiederhold, 1997). For a truly human-centered design, we need to move beyond the current bounds of what is popularly thought of as usability or user friendliness, and look at a larger context. We need to shift our focus beyond the immediate interactions between person and machine, toward the role those interactions play in the larger picture of human activity (Winograd and Woods, 1997).

Figure 1 Categories of IS Success (DeLone and McLean, 1992: p.62 and, 2002: p.24)



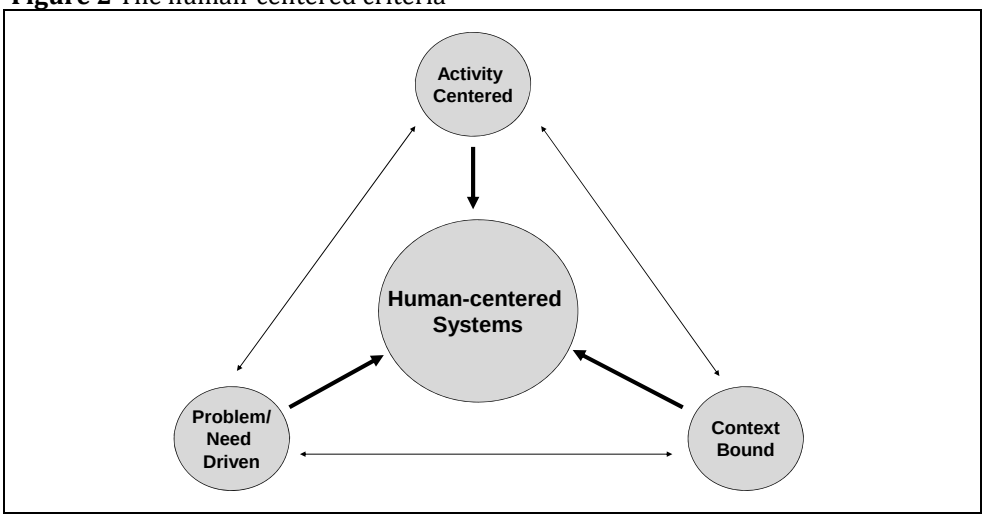
Human-centered development is about achieving synergy between the human and the machine. This synergism goes beyond human-computer interaction concepts, people in the loop philosophy and other interpretations given to human-centeredness. The informal theme of the National Science Foundation (NSF) workshop on human-centered systems (1997) was people propose, science studies, and technology conforms. In other words, humans are the centrepiece of human-centered research and design. The authors wish to promote this theme by formulating a set of measures for IS success based on the human-centered approach.

Three Human-Centered Criteria

This paper adopted the three criteria laid down in the NSF Workshop (1997). The three criteria depicted in Figure 2 are:

- Human-centered research and design is *problem/need driven* as against abstraction driven (although there is an overlap)
- Human-centered research and design is *activity centered*
- Human-centered research and design is *context bound* (Khosla et al., 2000).

Figure 2 The human-centered criteria



The first criterion *problem/need driven* outlines a need for developing software systems that are modelled based on how people use various artefacts to solve problems in a field of practice. The modelling should include not only the normal or repetitive tasks but also exceptional and challenging. These exceptional and challenging situations can also be likened to breakdowns in problem solving (Khosla, et al., 2000). For example in accounting area, a head of accounting department while recruiting new accounting clerks or bookkeepers is faced with an exceptional situation in determining a benchmark for recruiting the new accounting clerks. Further, this criterion also suggests the generic problem solving abstractions should be extracted from problem solving situations as people perceive and solve them, rather than employ abstract theories like graph theory or logic or other domain theories to solve problems in various fields.

Research by Vilpola (Vilpola, 2009) on the C-CEI (customer-centered ERP Implementation) method suggested three analyses that can be used when an ERP system is selected, implemented and taken into use namely operational analysis, contextual analysis and risk analysis. The problem/need driven criterion has been clearly consistent with Vilpola's operational analysis in terms of the focus on the critical business processes of a company (Vilpola, 2009).

The second criterion *activity centered* emphasises system development based on practitioners or users goals and tasks rather than system designer goals and tasks. In other words, this criterion emphasises the need for maximising the overlap between a user's model of the problem domain and a system's model of the domain. The focus is on how well the computer serves as an effective tool for accomplishing user's goals and tasks (Khosla, et al., 2000).

Finally, the third criterion *context bound* emphasises that human cognition, collaboration and performance is dependent upon context. It particularly looks at the representational context. That is, how the problem is represented influences the cognitive work needed to solve the problem. Problem solving is distributed across external and internal representations. Software systems based only on internal representations or models of a problem domain are likely to put a higher cognitive load on their users as against systems that are based on external or perceptual representations. Other contexts that need to be taken into account are

social/organisational context and task context as outlined in the second criteria (Khosla, et al., 2000). This criterion is consistent with Vilpola's contextual analysis that focuses on the organisational context such as users and their tasks, devices, and the physical and social environment (Vilpola, 2009).

The Human-Centered Dimensions and Hypotheses Development

Mäkipää described a model of ERP implementation that involves 10 stages and presents an alternative implementation path. These 10 stages are initiative, evaluation, selection, business process reengineering (BPR), modification, training, data conversion, go-live, termination and the last one is exploitation and development (Mäkipää, 2003). In this paper, the authors wish to suggest the use of the human-centered dimensions in measuring the human-centeredness of the SAP-ERP system at the early ERP implementation stages such as initiative, evaluation and selection stages. The business modules in the ERP system that have been used in the case study are financial module, purchasing module and HR module.

In order to develop a human-centered ERP system model, a set of dimensions need to be defined, along which user satisfaction can be measured and predicted. Several scholars have pointed out imperative dimensions can be considered for the design a human-centered ERP, such as Alter (2002), Stamper (1992), Ramamurthy & Premkumar (1995), Kling & Leigh (1997), Khosla *et al.* (2000), etc. We extracted the most significant 5 dimensions to construct the research model.

Figure 3 The conceptual model of the human-centered ERP system model

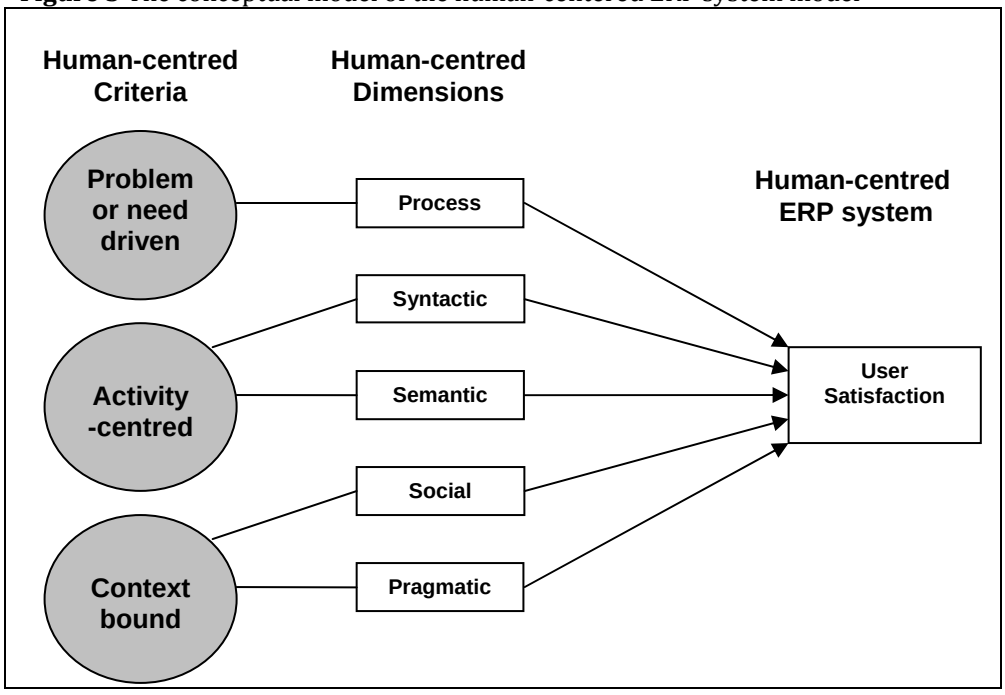


Figure 3 shows the proposed measurement model of the human-centered ERP system that measures the impact of the five human-centered dimensions on

user satisfaction. This analysis begins with considering the strategic decision making aspects of the human-centered approach. It suggests an investigation of the following questions: what human-centered measurement model can provide a systematic evaluation of ERP system? and what methodology can be used for validating the measurement model and how can it be applied for evaluating existing ERP system like SAP?

A questionnaire is designed with 14 questions (out of 20) in Section 3 designated to evaluate each human-centered dimension. Each of the five dimensions of the human-centeredness – process, syntactic, semantic, social and pragmatic – represents one independent variable. Hence, there are five independent variables involved in the analysis measured by 14 questions. This study measures the impact of these dimensions on user satisfaction, which is measured by two questions. All these 14 questions for 5 dimensions plus 2 questions for user satisfaction are explained in detail as below.

Process Dimension

The process dimension is based on the rationale that the system, as against technology or product, is used as a unit of analysis. In this context, human-centered design is consistent with the holistic or system-level view of information system design (Alter, 2002). In this system-level view, the system is the unit of analysis rather than the technology or tool. In other words, it is important to know whether the ERP system design has employed system rather than product as the unit of analysis.

Under the process dimension we investigate whether the ERP system allows flexibility in accepting variations for different users. The questions that are measured under the process dimension are:

1. The SAP system allows flexibility in accepting variations for different tasks (Q16).
2. The SAP system improves reliability (Q18).
3. The SAP system conforms to accounting or your business process related standards (Q19).
4. The SAP system can provide additional information which can improve your productivity Q20).

Therefore, based on the above rationales, the following hypothesis is postulated:

H1 There is a positive correlation between the process dimension and user satisfaction

Syntactic Dimension

The syntactic dimension has been developed to support the second activity-centered criterion of the human-centeredness. The syntactic concerns the structure of symbols and focuses on form rather than content. The syntax consists of the valid syntactic categories and the rules that govern their form (Stamper, 1992). For the purpose of the human-centered approach analysis, this dimension is used to measure the level of compatibility of the language, design, and artefacts/tools employed by the systems to the real tools used in doing the related tasks. System compatibility, which is used as a measurement under this dimension, was adapted from Ramamurthy and Premkumar (1995).

Under the syntactic dimension, for the purpose of this study, the focus is on the system compatibility with past accounting or business function-related tools, methods and systems; and with other retained technical systems in different business functions. The questions that are measured under the syntactic dimension are:

1 The SAP system is compatible with your past accounting or business function related tools, methods and systems (Q1).
2 The SAP system is compatible with other retained interface systems in different business functions (e.g., PCMS/Purchasing Card Management System in the Procurement Department) (Q2).

Therefore, based on the above rationale, the following hypothesis is postulated:

H2 There is a positive correlation between the syntactic dimension and user satisfaction

Semantic Dimension

The question of whose purposes are served in the development of an ERP system should be an explicit part of the system's design, evaluation, and use. Thus, the question of whose ideas are put into the design process is an important one with respect to human-centered systems. That is, how the information process is done in the system or how the various design/tools or methods are sequenced or ordered for processing information as well as, the question of whose problems are being solved. Systems which seek to answer only a very narrow technical or economic agenda or a set of theoretical technical points do not belong under the 'human-centered' rubric (Kling & Leigh, 1997).

Under semantic dimension, the more compatible a new system is with the way information is accessed, processed, and checked, the more satisfied the users will be. There is only one question that is measured under the semantic dimension is:

1 The way accounting or other business related information is accessed, processed and checked by the SAP system is compatible with the way it was accessed, processed and checked in your area before the introduction of SAP system or in your past experience (if you have recently joined the university?) (Q3).

Therefore, the following hypothesis is postulated:

H3 There is a positive correlation between the semantic dimension and user satisfaction

Social Dimension

From a social perspective, Khosla *et al.* (2000) outline that any changes in a system, either through computerisation or otherwise, are made as a result of optimisation of all components of the system, rather than by any one component (e.g., technology). Technology is invariably used as a means for satisfying the business goals and a system's success is determined in a business context rather than in a human context. The complexity of the technical state of the art also needs to be analysed. As stated in Bradford and Florin (2003), a common theme in ERP literature is the inherent complexity of ERP system (Bingi et al., 1999; O'Leary,

2000). From the technical point of view, complexity refers to the degree to which a certain innovation is difficult to understand and use (Roger, 1983). Ease of use is the degree to which a particular system is perceived to be relatively free from physical and mental effort (Davis, 1989).

Based on the above statement, it is possible to measure the ERP system's ease of use or complexity. The questions that are measured under the social dimension are:

1 The SAP system is easy to use (Q8).
2 The adoption of SAP has involved consensus among different stakeholders (e.g., you and the sponsors) at the strategic and operational levels of management (Q11).
3 SAP system has added new knowledge to your job related tasks or business function (Q12).
4 The design of SAP system is compatible with the accounting or other relevant business process culture you have experienced in the past at the university or other organisation (if you have recently joined the university) (Q13).

Therefore, the following hypothesis is postulated:

H4 There is a positive correlation between the social dimension and user satisfaction

Pragmatic Dimension

As with the architecture of buildings, the architecture of machines embodies questions of liveability and usability. The underlying system dimension is the pragmatic dimension. Based on the pragmatic dimension, it can be examined whether the information presented by the ERP system are easily understood and interpreted by the user and whether ERP system are effective in achieving business objectives, and in simplifying the job-related tasks. The questions that are measured under the pragmatic dimension are:

1 The information presented by the SAP system is easily understood and interpreted by you (Q4).

2 The information presented by the SAP system is effective in achieving your business objectives (Q5).

3 The SAP system has simplified your job-related tasks (Q7).

Therefore, the following hypothesis is postulated:

H5 There is a positive correlation between the pragmatic dimension and user satisfaction

User Satisfaction

In human-centered design, the technology or business process is designed to make participants' work as effective and satisfying as possible (Alter, 2002). Therefore, this study measures the impact of the five dimensional levels of human-centeredness on user satisfaction in utilising ERP system. Theoretically, effective information systems will provide high levels of user satisfaction.

There are two questions that were used to measure user satisfaction:

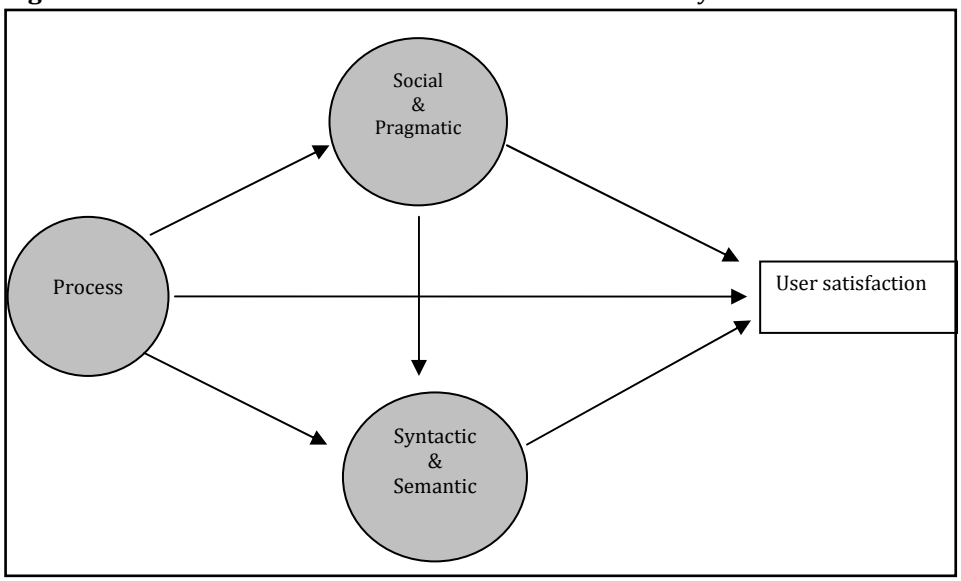
1 You are satisfied with the SAP system adopted by the university (Q9).

2 The SAP system provides you with job satisfaction and enhancement (Q10).

Hierarchical model

Figure 4 shows the proposed model of the hierarchical influences of the human-centered dimensions on user satisfaction. The model is constructively based on the rationale that the human-centered dimensions are derived from three human-centered criteria: problem or need driven, activity-driven, and context-bound (see also Figure 3 on page 9). In this conceptual model, problem or need-driven criteria are measured by process dimension. Activity-centered is measured on two dimensions – syntactic and semantic. Context-bound is measured by social and pragmatic dimensions.

Figure 4 The hierarchical model of the human-centred ERP system



The problem/need driven criteria, which is measured by process dimension, is in the top level of the hierarchy that influence the context-bound criteria. The context-centeredness of the SAP design, which is measured by social and pragmatic dimensions, will be dependent upon whether the system has been designed based on the need and the problems of its users. Fulfilling the context-bound criteria will affect the activity-centeredness of the SAP system, which is measured by syntactic and semantic dimensions.

Thus, process dimension will be entered in Stage 1, social and pragmatic dimensions will be entered in Stage 2, followed by syntactic and semantic dimensions entered in Stage 3. It is suggested in this study that the variation of hierarchical impacts of the model is commonly exists in the ERP system deployment/implementation.

Based on the above rationale of the hierarchical model of the human-centered system, the following is postulated:

H6 The hierarchical impact of the human-centered dimensions significantly increase the user satisfaction, both directly and indirectly

Research Methodology

There has not been any empirical study that tests the human-centeredness of the ERP system as far as the authors are aware. Neither has any human-centered dimension been used to measure the human-centeredness of the SAP system. Therefore, testing the above hypotheses can contribute theoretically and empirically. Based on the hypothesis established in previous section, this section outlines a quantitative based research methodology in this research.

Case Study Selection

Since universities are substantial and experienced users of IT and a significant number have emerged as purchasers of ERP system (Oliver & Romm, 2002), a university is chosen for the case studyRands (1992) argued that the requirements for software acquisition vary considerably across different industries. Universities are a specific vertical market targeted by ERP vendors that conveniently feature stability on the supply side as well as on the demand side.

Studies of the implications of ERP system for universities have been conducted (*e.g*., Scott & Wagner, 2004; Pollock & Cornford, 2004). Cunningham *et al*. (1998) noted the potential use of ERP in reshaping organisational aspects. Pollock and Cornford (2004) suggested that the significance of these systems would be better appreciated and understood if IS researchers were to resist viewing universities (or, for that matter, computer systems) as stable entities.

Universities have recently turned to ERP system as a means of replacing existing management and administration computer systems. Since universities face similar challenges to a wide range of organisations, the standard tools of contemporary organisational analysis and institutional management –including computer systems used by large corporations around the world, such as ERP system – can be similarly applied in their case (Pollock & Cornford, 2004).

This study also looks at ERP system as software packages that have been implemented and used in a university in Australia. The institution has eight campuses spread across the state of Victoria and currently has more than 26,000 students. It has 5 faculties and offers more than 140 courses in a variety of disciplines. The university has been using SAP as an ERP system for about ten years.

Questionnaire

A questionnaire, as shown in the Appendix, distributed by electronic mail (email) is used as the research instruments for this study. The electronic mail questionnaire is carefully administered in order to optimise the authentication of the response and to maximise the expected outcome from the survey. The email questionnaires are sent out to 773 prospective respondents through electronic mail and 131 of which finally completed the questionnaire and are included in this study (or just under 17 per cent).

The questionnaire comprises the following four sections: information about the user (respondent's attributes), implementation of SAP as an ERP System, evaluation of SAP as an ERP System, and user's overall comments on the SAP System (open-ended questions). The main intention of this paper is to measure the human-centeredness of the SAP system using the five human-centered dimensions. These measure applies a five-point Likert-type scale ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, and 5 = Strongly Agree.

Data analysis

Data are analysed using summated scale index for analysis of quantitative variables, reliability test of quantitative variables, and univariate and bivariate analyses technique for data analysis including the hierarchical regression analysis. The qualitative data collected from the open-ended question (the last section of the questionairre) are content-analysed and used descriptively to illustrate issues under the human-centered perspective.

In terms of Respondent attributes as listed in Section 1 of the Questionnaire in the Appendix, the results in Table 1 reveal that 27 per cent of the respondents are managerial level and 73 per cent are non-managerial.

Table 1 Information about the user

Sections	Number	Per cent
1. Position in the Business		
Managerial	35	26.7
Non-managerial	96	73.3
2. Length of time working in the organisation		
Less than 5 years	63	48.1
Between 5 and 10 years	49	37.4
Longer than 10 years	19	14.5
3. Length of time using SAP systems		
Less than 5 years	83	63.3
5 years or longer	48	36.7
4. Frequency of using SAP systems per week		
Less than 3 days per week	39	29.8
3 days or more per week	92	70.2
5. User is an accountant by profession		
Yes	18	13.7
No	113	86.3
6. User has adequate prior skills and knowledge about the operation of SAP system before working on SAP system at the university.		
Yes	46	35
No	85	65

Most of the respondents to this survey (i) have worked for the organisation for up to 10 years; (ii) have used the SAP system for less than five years; and (iii) use SAP three days or more per week. 14 per cent of the respondents are accountant leaving 86 per cent non-accountant respondents.

The results in Table 1 also reveal that 65 per cent of the respondents had no adequate SAP skills prior to using this system in the organisation leaving 35 per

cent who had adequate prior SAP skills, either through user involvement in the system deployment/implementation stages, meetings or SAP training programs.

Reliability analysis is undertaken to test whether the variables used for summated scales are internally reliable and stable. Table 2 shows the reliability of all variables that has been between 0.75 and 0.86 except for syntactic and social dimensions. The results reveal that the process, social, syntactic and pragmatic dimensions are statistically reliable and consistent. The reliability of social (α = 0.61) and syntactic (α = 0.60) is lower than pragmatic and process and only marginally above the 0.60 threshold of acceptability but is still considered as acceptable for the purposes of this study. The reliability of semantic dimension is not available as it is measured by only a single question. Meanwhile the reliability of user satisfaction as the dependent variable is highly reliable and consistent with Cronbach's α = 0.86.

Table 2 Reliability Results

No	Variables	Type of Variable	No of items	Inter-item correlations	Chronbach's α
1	Process	Independent	4	.44	.75
2	Syntactic	Independent	2	.43	.60
3	Semantic	Independent	1	N/A*	N/A*
4	Social	Independent	4	.28	.61
5	Pragmatic	Independent	3	.57	.80
6	User satisfaction	Dependent	2	.75	.86

** Semantic has only one item (N/A = not available)*

The statistical methods used in this paper are based on summated scaling and least squares regression since this study explores a relatively small number of respondents (less than 150). With summated scale, the number of measurement category is relatively large. For example, Process dimension is a sum of four items; each scores 1 – 5, resulting in a scale ranging from 5 – 25. Scales such as this are commonly treated as interval scales in the research literature and the univariate attribute summarised in terms of *mean* and *standard deviation* (SD).

Table 3 displays the comparison of score, mean, standard deviation and variance for each of the human-centered dimensions, as well as for user satisfaction. Each variable is measured on a five-point scale where '1' indicates the lowest level of the score and '5' indicates the highest.

Table 3 Comparison of score, mean, standard deviation and variance

No	Variable	N	Range	Min	Max	Mean	SD	Variance
1	Process	131	3.75	1	4.75	3.29	.70	.50
2	Syntactic	131	4	1	5	3.33	.86	.74
3	Semantic	131	4	1	5	3.07	.88	.77
4	Social	131	3.75	1	4.75	3.18	.67	.44
5	Pragmatic	131	4	1	5	3.40	.96	.92
6	User satisfaction	131	4	1	5	2.96	1.08	1.17

SD = *standard deviation*

As shown by the mean score of each dimension in Table 3, on average the respondents scored the dimensions above the middle scale of 3. The means range from 3.07 to 3.40. This result shows a majority of the respondents agreed that SAP

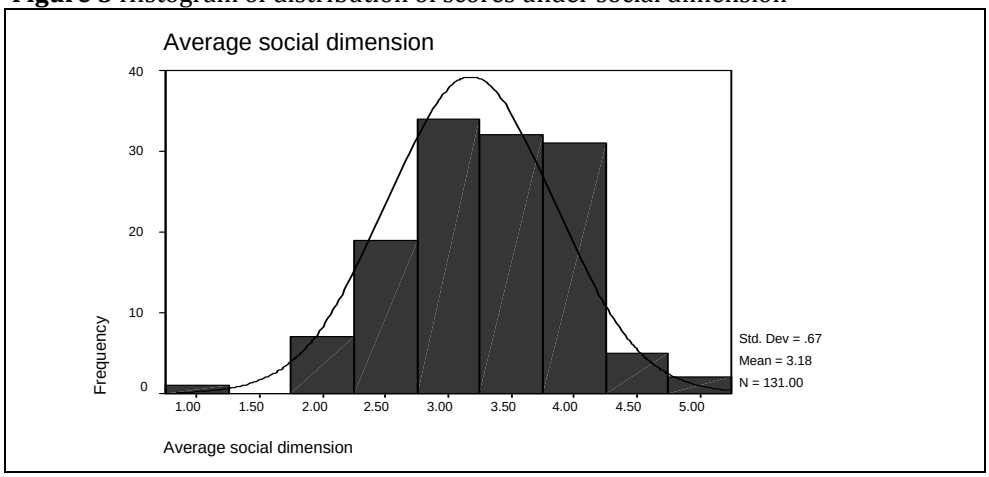
system design is human-centered. The table also shows that the dispersion of score in pragmatic dimension has been the highest among the five human-centered dimensions [*SD=0.96*] which shows more variation of scores in terms of pragmatic point of view.

The mean score of 3.29 on the 5-point scale for process dimension in Table 3 indicates that a majority of the respondents agreed that SAP system design is process driven. The results indicate that most users believe that the SAP system design matches the job-related tasks rather than being primarily driven by the need for automation or perceived notions of efficiency.

In terms of the syntactic dimension, again, statistically speaking the majority of respondents believes that the design of SAP was based on the activity-centered principle and tools and methods used in the organisation prior to introduction of SAP. The mean score for syntactic (*3.33)* lies clearly above the mid-point of 3. However, it needs to be noted that SAP was introduced in the organisation more than ten years before the data were collected. Thus qualitatively the feedback provided by respondents with longer than ten years experience in the organisation (14.5% as shown in Table 1) can be considered as valid. In other words, employees with less than ten years experience (85.5% as shown in Table 1) were less likely to experience the tools and methods used in practice prior to introduction of SAP.

Table 3 shows that the mean of semantic is slightly higher than 3 [*mean = 3.07*] and the majority of scores lie on the mid-point. It indicates that most of the respondents were unsure about the SAP system compatibility with the user's activity and business culture. Overall, most users are uncertain about the semantic aspect of SAP. One of the reasons the mean of semantic is less than syntactic and process was that the number of 'not sure' responses from respondents was comparatively more than in other dimensions. Here also it needs to be noted that qualitatively the feedback from respondents with more than ten years experience can be considered as valid. This is so because 85.5 per cent of the respondents started work in the organisation after introduction of SAP and they are unlikely to have knowledge and experience of how information was processed by tools and methods used prior to the introduction of SAP.

Figure 5 Histogram of distribution of scores under social dimension

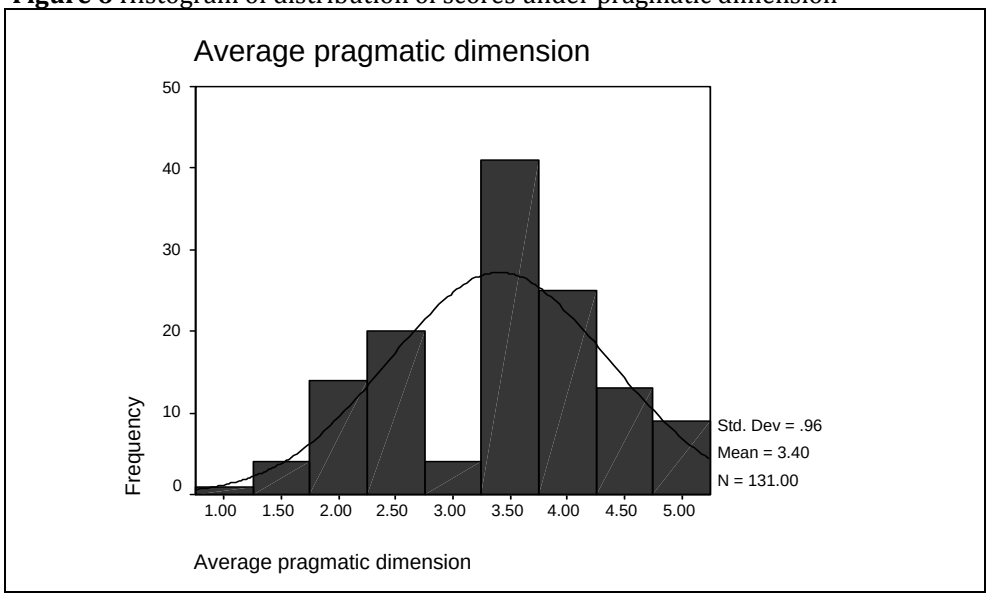


The distribution of scores for the social dimension shown in Table 3 indicates the majority of respondents consider SAP as context-centered. Although the mean score of social is slightly higher than 3 [*mean = 3.18*], the majority of responses fall in the range from 3-4 point on the scale (53% as shown in Figure 5). Nearly one-third of the total responses in Figure 5 report low scores (32%). Meanwhile, 15 per cent of respondents were unsure whether SAP was context-centered. In summary, most respondents agree that, from the social dimension perspective, SAP is context-centered.

Table 3 also indicates overall that respondents broadly agreed that SAP is pragmatically context-centered [*mean = 3.40*]. The highest score lies just above the mid-point of 3 (21 per cent) and more than one third of the total responses were of 4 and 5. As depicted in Figure 6, about 30 per cent of the respondents do not believe that SAP is pragmatic.

In summary, this result indicates that approximately 66 per cent of the respondents agreed that SAP design takes into account pragmatic consideration.

Figure 6 Histogram of distribution of scores under pragmatic dimension



By applying the human-centered ERP system as measurement tools, the human-centeredness of the SAP system is found to be moderate, except for the semantic dimension that predominantly shows 'not-sure' responses from the respondents. Further, based on respondents attributes like length of time working in the organisation, a majority of responses from respondents are less likely to be valid.

The mean score for user satisfaction, however, is just slightly below the middle scale of 3. This result indicates that on average the majority of the SAP users were not sure whether they are satisfied with the SAP system adopted by the university. The users were also not sure that The SAP system provides them with job satisfaction and enhancement.

Research Findings

The correlations between human-centered dimensions and user satisfaction are what we like to examine in research findings. The hypotheses, postulated in this paper, focus on the links of the human-centered dimensions and user satisfaction.

The correlations between the human-centered dimensions and user satisfaction are presented in Table 4. The zero order correlation *r* measures the linear associations between the following variables: process, syntactic, semantic, social, pragmatic dimensions, and user satisfaction. An asterisk is used to denote correlations that are statistically significant (i.e., rejecting the null hypothesis that *r* = 0). Table 4 shows that all the variables are highly inter-correlated and that the correlations are statistically significant. The correlations in Table 4 range between +.38 and +.76.

The result in Table 4 reveals that an entrenched process level view in ERP systems design leads to higher user satisfaction. That is, the stronger is the process dimension, the higher is the user satisfaction. Table 4 shows a highly positive correlation between process dimension and user satisfaction [*r=.71, n=131, p<0.01*]. This indicates that respondents viewed SAP as a system designed to model the job-related tasks of users and to create higher user satisfaction. This result supports H1.

The purpose of the syntactic analysis is to measure the system compatibility of the language, design, and artefacts/tools employed by the systems to the real tools used in doing the related tasks. Theoretically, the more precise is the syntax in representing the tools in the actual situation, the higher is the system compatibility level and, hence, it is predicted that the user will get more satisfaction and the organisational benefits may be easier to achieve. The results in Table 4 reveal that the stronger is the syntactic dimension, the more likely is the user to be satisfied with SAP. The correlation between the syntactic dimension and user satisfaction was strongly positive and significant [*r=.45, n=131, p<0.01*]. The respondents believed that SAP was highly compatible with the past accounting or business function-related tools, methods, and systems and, thus, increased user satisfaction. This result supports H2.

In terms of the semantic dimension, the question of which features are incorporated into the design process is an important one for human-centered systems. It was hypothesised that the more compatible the new system is with the way information is accessed, processed, and checked by the previous system, the more satisfied will be the users with the ERP system. Additionally, it was also predicted that if the semantic dimension was applied in the system design, then SAP tends to create more benefits to the organisation.

The results in Table 4 show that higher semantic levels are associated with increased user satisfaction. There is a moderately positive and significant correlation between the semantic dimension and user satisfaction [*r=.44, n=131, p<0.01*]. This result supports H3.

In measuring the social level of the SAP systems, *social units,* that structure work and information, organisations and teams, communities and their distinctive social processes, and practices, must be taken into account. The social dimension analysis involves aspects related to ease of use, involvement of consensus among stakeholders, addition of new knowledge, and business process culture compatibility. A strong commitment on the social dimension is associated with increased user satisfaction. The correlation between the social dimension and user satisfaction is strong, positive, and statistically significant [*r=.67, n=131, p<0.01*].

Respondents who agreed that the adoption of SAP had involved consensus among different stakeholders tend to be more satisfied with SAP. This result supports H4.

The focus in measuring the pragmatic dimension is on understanding the usability of the accounting software system. The degree to which each stakeholder group understands the structure of the accounting software system is observed. A high pragmatic level exists when the information provided by the ERP systems is easily understood by the users. Thus, the pragmatic dimension analysis involves aspects related to whether the information presented by SAP is easily understood and interpreted by users, effective in achieving business objectives, and simplified job-related tasks. The results of Table 4 reveal that high levels of the pragmatic dimension of SAP are associated with higher user satisfaction. The correlation between the pragmatic dimension and user satisfaction is very strong, positive and significant [$r=.76,\ n=131,\ p<0.01$]. In other words, people who agree that the information presented by SAP is pragmatic, tend to be more satisfied with SAP. This result supports H5.

In summary, the strongest correlations are between pragmatic and user satisfaction (r=.76), and process and user satisfaction (r=.71). The remaining dimensions are moderately-to-strongly correlated and all correlations are statistically significant. Thus, based on the results in Table 4 we can conclude that H1, H2, H3, H4 and H5 have been fully supported.

Table 4 Correlations between user satisfaction and human-centered dimensions

Variables		1	2	3	4	5	6
1	User satisfaction	1.00					
2	Process (H1)	**.71***	1.00				
3	Syntactic (H2)	**.45***	**.43***	1.00			
4	Semantic (H3)	**.44***	**.40***	**.68***	1.00		
5	Social (H4)	**.67***	**.66***	**.49***	**.60***	1.00	
6	Pragmatic (H5)	**.76***	**.65***	**.45***	**.38***	**.68***	1.00

** Correlation is significant at the 0.01 level (2-tailed)*

Among the five human-centered dimensions, the pragmatic dimension is the most consistent and the most reliable, followed by the process, social, and syntactic dimensions. This evidence indicates that the human-centeredness level of SAP is fairly moderate.

Table 5 outlined the result of testing the human-centered model of ERP systems. It shows impacts of the human-centered dimensions on user satisfaction applying multiple regression analysis. The process dimension was entered into the regression equation in Stage 1, the social and the pragmatic dimensions will be entered in Stage 2, followed by the syntactic and the semantic dimensions entered in Stage 3. It is suggested in this study that this variation of hierarchical impacts of the model commonly exists in the ERP system deployment / implementation.

Stage 1 is when the process dimension by itself very strongly influences user satisfaction of SAP [$B=.71,\ p<0.01$] and accounts for half of the variation in user satisfaction [$R^2=0.50,\ F(1,129)=127.90,\ p<0.01$]. The social and the pragmatic dimensions were entered in Stage 2. Among the five dimensions, the pragmatic one had the most substantial impact on user satisfaction with SAP [$B=.45,\ p<0.01$]. The impact of the process dimension on user satisfaction dropped by more than one half but it remains strong and statistically significant [$B=.31,\ p<0.01$]. The social dimension has little impact on user satisfaction [$B=.17,\ p>0.05$]. These three

dimensions collectively explain 67 per cent of the variation in user satisfaction or add 17 per cent of variations compared to Stage 1 [R^2*=0.67, F(3,127)=85.16, p<0.01*]. Thus, at this stage, the pragmatic dimension and the process dimension are the main important aspects in predicting user satisfaction.

Table 5 Variation of the hierarchical impact of the human-centered dimensions on user satisfaction

	Stage 1	**Stage 2**	**Stage 3**
Human-centered Dimensions	**Standardised Regression Coefficients**	**Standardised Regression Coefficients**	**Standardised Regression Coefficients**
Process	**.71****	**.31****	**.30****
Social		.17	.12
Pragmatic		**.45****	**.45****
Syntactic			.00
Semantic			.08
R^2 =	0.50	0.67	0.67
SE_Y =	0.77	0.63	0.63
R^2 Change =		0.17**	0.00

N=131 * *p<0.05* ** *p<0.01*

The syntactic dimension and the semantic dimension were taken into account in Stage 3. The results show that the impact of the pragmatic and the process dimensions on user satisfaction remain stable and substantial ([*B=.45, p<0.01*] and [*B=.30, p<0.01*] respectively). The impacts of the social dimension on user satisfaction is weak and not significant [*B=.12, p>0.05*]. Meanwhile, the syntactic dimension and semantic dimension had no impact on user satisfaction ([*B=.00, p>0.05*], and [*B=.08, p>0.05*] respectively). The results also show that the inclusion of the syntactic dimension and the semantic dimension in the model did not create any additional variations in user satisfaction [R^2*=0.67, F(5,125)=51.17, p<0.01*]. Thus the five human-centered dimensions collectively account for 67 per cent of total variations in user satisfaction. This result again suggests that the pragmatic dimension and the process dimension of the SAP system are the key attributes in the human-centered ERP system design.

The indirect influences for the hierarchical model in Figure 4 (on page 12) are illustrated in Table 6. The results indicate that the indirect effect of the process dimension on user satisfaction via the social, pragmatic, syntactic, and semantic is the most substantial one [*B=.41, p<0.01*]. The indirect effects of the social dimension and the pragmatic dimension on user satisfaction are not significant.

Table 6 Decomposition of direct and indirect effects of the human-centered dimensions on user satisfaction

Human-centered Dimensions	**Direct Influence**	**Indirect Influence**	**Total Influence**
Process	**.30****	**.41****	**.71****
Social	.12	.05	.17
Pragmatic	**.45****	.00	**.45****
Syntactic	.09	-	.09

Semantic	.00	-	.00

*N=131 * p<0.05 ** p<0.01*

The pragmatic dimension has the most substantial direct impact on user satisfaction followed by the process dimension. However, it is only the process dimension that contributes a strong and significant indirect effect on user satisfaction through the other dimensions. Therefore, based on the results in Tables 5 and 6 we can conclude that H6 has been partly supported.

A summary of opinions of best features of SAP systems, as the results from the open-ended questions (the last section of the questionnaire), is shown in Table 7. There were 82 comments summarised in Table 7 and classified into positive and negative opinions based on the five human-centered dimensions. The user satisfaction level of SAP reflects the fact that most of the respondents had a high opinion of SAP.

Table 7 Summary of opinions on the best features of SAP systems

Human-Centered Dimension	Respondent's opinion					
	Positive opinion		Negative opinion		Total	
	Freq.	%	Freq.	%	Freq.	%
Process	22	79	6	21	28	100
Syntactic	10	83	2	17	12	100
Semantic	14	93	1	7	15	100
Social	9	82	2	18	11	100
Pragmatic	13	81	3	19	16	100
Total	**68**	**N/A**	**14**	**N/A**	**82**	**100**

It is also noted in this research that there were several specific factors, however, raised in the survey that need to be considered for improvements in SAP in the future such as the business processes, efficiency and flexibility, real time journal access, log out time, unnecessary steps, uploading journal entries, paper work, viewing access to HR accounts and transactions.

Conclusions

Most of the existing ERP systems have adopted a product or technology centered rather than a human-centered approach in their design. The benefits of an ERP system like SAP have been varied from organisation to organisation. As a consequence, in the past few years researchers have looked at user or human-centered aspects of ERP system and other reasons responsible for the limited or varied success of the ERP system, and concluded that proper ERP system design should be considered carefully in the very beginning. They found that the ERP system success can be measured by the level of user satisfaction and organisational performance or benefits. A lack of human-centered ERP design motivates this research to develop a systematic human-centered ERP evaluation model consists of social, syntactic, semantic, process and pragmatic quality.

The objective of the paper is to learn and measure a hierarchical influence of five human-centered dimensions on user satisfaction both directly and indirectly. This research has developed a set of dimensions and measures for assessing the human-centeredness of existing ERP system. It defines a methodology for

validating the measurement model and applies the methodology in the evaluation of the SAP system used in a tertiary education institution in Australia.

Based on the results of the multiple regression analysis, it was learnt that the pragmatic and the process consistently had strong *direct* and substantial influences on user satisfaction across the four models. It was also learnt that the process dimension also had a strong and substantial *indirect* influence on user satisfaction. Therefore, the hierarchical model partly supported the hypothesis.

The results reveal that the involvement of the syntactic and the semantic dimensions in the models did not show significant influence on user satisfaction. However, the majority of respondents felt that SAP is activity-centred, based on the analysis of the syntactic dimension. In other words, basically most of the respondents agree that SAP is human-centred. The results indicate that, in terms of the syntactic dimension, only the accountants felt that SAP is activity-centred.

By answering the proposed research questions and hypotheses, the research makes the following contributions to knowledge: 1). It establishes the need for the human-centered approach as a basis for the design of ERP system; 2). It defines a systematic human-centered model for measurement of ERP system, in particular, and accounting information systems, in general; and 3). It develops methodology for validation of the measurement model and applies it to evaluation of ERP system.

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