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Using a Knowledge Management Evaluation Framework for Improving an ERP System – A Hong Kong Construction Industry Case Study

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Abstract. Organisations need to rely on leadership, information support and human capital in order to ensure a knowledge advantage over their competitors. Knowledge management (KM) provides organisations with sustainable competitive advantage, because it becomes extremely difficult for an organisation to cut expenditure and increase revenue by simply reengineering its business model. Project delivery and success has been traditionally viewed and measured as management of a three-legged stool, with the legs defined as cost, schedule and quality. However, KM can be linked to success by organisations becoming more effective as well as being more efficient.

This paper uses a KM framework, the Knowledge Advantage (K-Adv), developed initially for use by construction organisations. It assesses the impact of leadership and its supporting information communication technology infrastructure on the ability of people (by effectively creating, sharing, disseminating and using knowledge) to facilitate sustainable competitive advantage.

A case study that is presented is based upon the experience of a leading construction company using an Enterprise Resources Planning (ERP) system to demonstrate the effectiveness of KM from a cost management business unit perspective. Results are evaluated using a capability maturity model (CMM) - that forms the core of the K-Adv tool - to help improve processes that meet the needs of the organisation operating in a highly dynamic business environment. The case study is part of a broader doctoral research project that uses action learning to facilitate and measure ERP improvement.

Introduction

There is a Chinese proverb from the “The Art of War - “知己知彼,百戰百勝 (zhi ji zhi bi, bai zhan bai sheng)”, that means if you know yourself as well as your enemy, you will come out of one hundred battles with one hundred victories (Sun and Clavell, 1983). This also applies to the business world because good application of knowledge management (KM) always puts the organisation into a

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potentially winning position. In the construction industry, project delivery and success is often based upon the 'iron triangle' criteria of cost, schedule and quality. However, project managers find it extremely difficult to fulfil these requirements using only this basic information or knowledge. Effectively exercising project control requires accurate current, relevant data and information and the knowledge, skill and expertise to effectively analyse data and information and make sound decisions based on that input. Part of the problem faced by users of project management (PM) data and information is 'information overload' and various strategies have been developed in an attempt to overcome such problems including increasing the extent of visualisation and graphic representation of information (Songer, Hays and North, 2004). Another approach is to improve the use of knowledge of interpreting data and information and its application to solve problems through concentrating upon gaining a knowledge advantage that delivers a strategic advantage (Prusak, 1996; Walker, 2005).

Fortunately, there are information communication technology (ICT) tools that can assist project managers to improve information quality and facilitate KM. This prompts an interesting question, how can effectiveness of these tools be evaluated for this purpose? This paper is concerned with highlighting how to assess and evaluate the effectiveness of using such ICT tools through testing a framework that uses a KM capability maturity model (CMM) approach. The scope of the paper is necessarily limited and so is focused on a case study evaluation of a specific ICT tool used by a major regional construction contractor operating in Hong Kong. The purpose of this paper is to thus explore and present an evaluation framework for improving the use of Enterprise Resource Program (ERP) tools with a specific focus on cost management to help construction contractors better manage project control systems.

The paper is structured as follows. First having provided a brief introduction of the context for the paper, some theoretical issues addressed by the paper are then discussed. The case study details are then briefly described. Next, collected data from a pilot survey of current users of the ERP system is presented that was undertaken to assess the system's current maturity level as perceived by those surveyed. Finally, a discussion of results and our conclusions are provided.

Theoretical Issues Underpinning the Research

Effective project cost management requires access to accurate, current, reliable data and information and is concerned with establishing processes to monitor and control budgets (Cleland, 1999). In addition, the data needs to be understood in the context of the specific case where the knowledge was created. Project cost management in the construction industry is a highly information and knowledge management intensive activity. It encompasses knowledge relating to expectations of parties in a supply chain, knowledge assets that can be shared and enhanced that relate to delivery methods/techniques, business models, opportunities for synergies and market intelligence etc. It includes (Smith, 1998; Smith and Love, 2000; Hughes, 2006):

1. High levels of project context-specific cost estimation and budgeting knowledge and

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information to develop conceptual budgets and financial feasibility studies during the project design phase through to the pre-tender phase before a project is tendered.

2. Value management to question, probe and challenge the design to explore and evaluate alternatives that represent improved value for money.
3. Generating marketing intelligence and knowledge through evaluating tender submissions from outsourced entities and consolidating these into a tender submission
4. Generating relationship and cost minimisation knowledge through negotiating costs and conditions of contract with outsourced suppliers and subcontractors during the tender phase.
5. Extending project-contextual knowledge through managing and negotiating contract variations to the agreed contract sum (contract change management) at the project implementation phase.
6. Generating both upstream and downstream supply chain expectation and relational knowledge through administrating head contracts with a client and contracts with outsourced subcontractors and suppliers.

Because cost management is such an intensely information and knowledge-rich set of activities, information technology (IT) systems have been an increasing feature of its development over several decades, see for example Mathur, Betts and Kwok (1993). There has been widespread acceptance that ICT is a key enabler of KM that enhances a firm's potential for gaining competitive advantage (Peansupap, 2004; Walker, 2005; Maqsood, 2006). KM involves creating, sharing, disseminating, and utilizing knowledge data within organisation (Davenport and Prusak, 1998). KM, supported by an effective ICT infrastructure, can facilitate competitive advantages in at least two ways—having a cost advantage or a differentiation advantage (Walker, 2005). First, by better knowing the source and context of costs, a firm can achieve cost advantage for example by having superior knowledge of the range and performance of sub-contractors or suppliers or by having a superior cost management system that allows better cause-and effect understanding for internal direct costs. Better knowledge of wastage rates and their reasons provides but one example. A differentiation competitive advantage example may be firms having superior market knowledge, or effective and innovative processes, that make a firm a partner of first choice. However, having this kind of knowledge is not by itself sufficient to guarantee competitive advantage. Thus, an effective KM system, allows construction firms to create share and use critical knowledge and this can provide the competitive advantage that distinguishes it from its competitors.

Each member of a project team generally possesses information and knowledge that can benefit the projects. To maintain the project management intellectual property, organisation must provide the vehicles for capturing data and information and then disseminating it to the various parts of the project team. People are best at transferring and reframing knowledge through personal interaction in groups that share trust and passion and are willing to volunteer this knowledge to each other. This is where communities of practice (COPs) can help people share knowledge and skills and help sustain its members through their obligation to exchange knowledge and provide access to shared insights about their work

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practice (Wenger *et al.*, 2002). This data and information can then be contextualised, re-framed to reflect its current context, used and through this process become enhanced to form knowledge. The way that KM is approached is therefore becoming critically important in the project business model. Those organisations that can better harness their knowledge in their projects are more likely to realise competitive advantage from doing so.

According to (Zack, 1999), knowledge can be characterized in many ways. Popular taxonomies distinguish between tacit and explicit, general and situated context-specific, and individual and collective. Knowledge can also be categorised by type, including declarative (knowing about), procedural (know how) causal (know why) conditional (know when) and relational (know with).

Codified (explicit) knowledge can be effectively transferred with the support of an efficient ICT system. Knowledge that is difficult to codify that remains in a persons' head or is embedded in their habits and ways that they automatically undertake their work is called tacit knowledge. People best transfer and reframe this kind of knowledge through personal interaction in groups that share a particular passion and are willing to volunteer this knowledge to each other. These groups are referred to as communities of practice (COPs). A COP shares knowledge and skills and sustains its members through obligations to exchange knowledge, providing access and accessibility to shared insights and knowledge the practice of work. (Wenger, McDermott and Snyder, 2002).

ICT can allow COPs to assemble in a virtual space to exchange knowledge and work together. Jewell and Walker (2005) provide a construction industry case study of how an ICT COP application assisted in this type of knowledge work. KM can be seen as following two primary strategies; *codification* and *personalisation* (Hansen, Nohria and Tierney, 1999). Codification involves the collection, coding and storage of data, information and knowledge that is accessible by others with appropriate access rights. Personalisation provides for the sharing of information by osmosis within the organisation; there is little formalisation of knowledge transfer processes in place and knowledge is personally passed from individual to individual. Each of these strategies has merit within an organisational framework, although for the success of a project based ICT solution, codification is required as it provides the framework for information and a formalisation of data and its value to both the individual and the organisation. While the Hansen *et al.* (1999) strategic approach recommends that an 80-20% ratio be applied when mixing strategies so that one is clearly dominant, others have demonstrated that use of a range of mixes may be appropriate given different contexts (Scheepers, Venkitachalam and Gibbs, 2004).

Whatever the KM strategy that is adopted, firms can develop what Walker (2005) refers to as a knowledge advantage (K-Adv). This concept is presented in Figure 1.

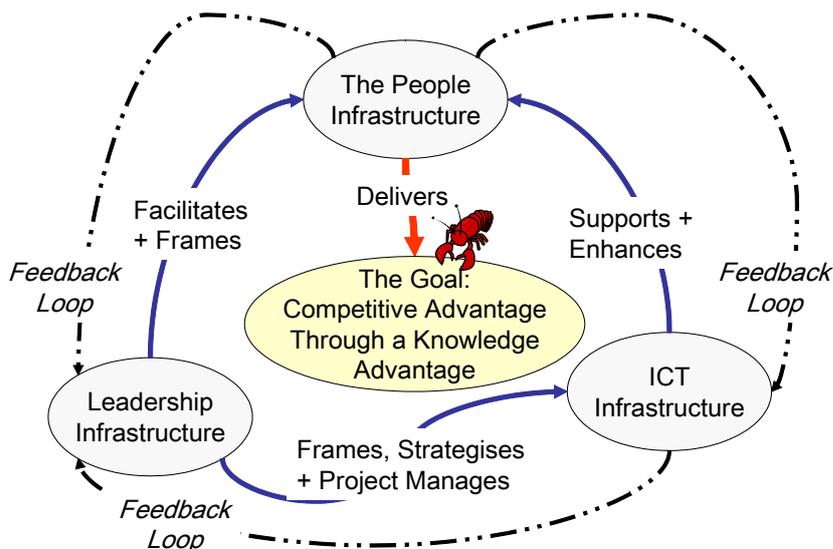


Figure 1 - The Knowledge Advantage Concept

Figure 1 clearly indicates that people drive the KM process using data, information and knowledge. The ICT support system, whether using a codification or personalisation knowledge strategy, requires strategy and leadership that supports its effective establishment and maintenance. Moreover, the strategy needs to support the development of a knowledge sharing culture and reward system accordingly. Many organisations use Enterprise Resource Planning (ERP) systems as their ICT backbone. Al-Mashari, Al-Mudimigh and Zairi (2003) describe ERP systems as customised standard integrated software applications that facilitate IT coordination in control aspects of management and other operational facets such as human resource management and logistics. ERP systems also can integrate numerous project management control processes such as cost and time management. They are thus intended to be integrated production solutions be that for manufacturing or project delivery. They also link to groupware that allows communication and coordination, joint problem solving and recording transaction histories. In this way they can be seen as facilitating (codified) knowledge management in that they are capable of facilitating groups of people to solve specific problems (such as how to best manage project costs) and through the audit trail of data to trace the evolution of decision-making and its consequences. An ERP system is not a KM system but a tool that in theory should reduce management effort in gathering, storing and using data or information so that more effort and creative energy can be devoted to analysing and contextualising information and refining it into knowledge (because it embodies context and thus embeds some of the tacit knowledge relating to hypothesised causal links and important work practice-specific cultural factors that may shape a decision). So the significance of an ERP system being used is not indicative of a KM application being used, rather that the unburdening of administrative effort through effective ERP tools allows management energy to be directed towards knowledge-based activities of creating meaning out of information, transferring the significance of that meaning to others and using the refined knowledge to practically solve problems. This perspective of ERP as an IT tool (and a precursor to a KM tool) allows us to focus upon how ERP system implementation effectiveness

can facilitate KM initiatives to grasp space in a crowded corporate agenda for improvement, so that **both** efficiency and effectiveness are addressed. The strength of ERP systems, as well as other portal systems used for project control, is that they should unleash creative energies to use knowledge to improve productivity in its widest sense. This resonates with the concept of gaining a knowledge advantage (Walker, Wilson and Srikanathan, 2004).

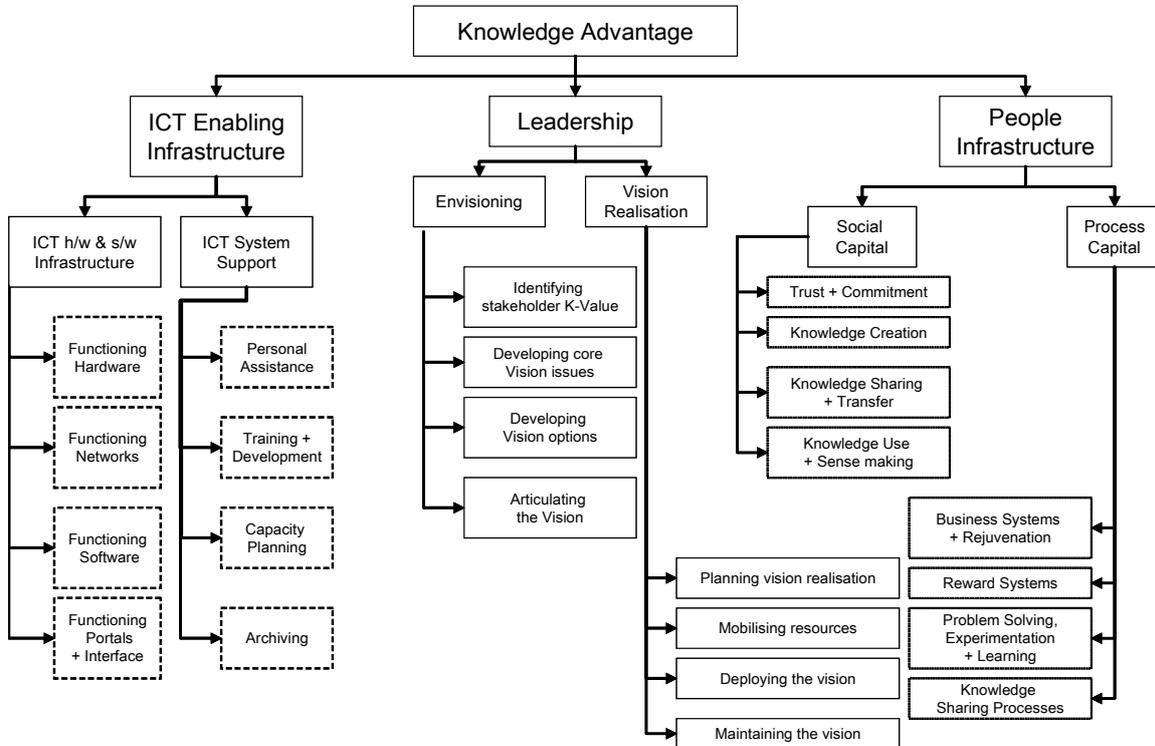


Figure 2 - The K-Adv Elements

Figure 2 illustrates the K-Adv in more detail. Each of the three infrastructure elements is presented with their break down structure. Interested readers should refer to Walker, Wilson and Srikanathan (2004) for a more detailed explanation. Each of the above elements are linked into a capability maturity model (CMM) that helps to identify the level of maturity of the K-Adv implementation and adoption. For example for the high level element IT Enabling Infrastructure, Table 1 offers a CMM tool to categorise an organisation’s maturity level as evidenced from observation, interview responses or any other investigative form of research into how KM is approached in the organisation.

Table 1 - Maturity levels of ICT Enabling Infrastructure

| Maturity | ICT s/w & h/w infrastructure | ICT System support |
|--|--|--|
| How can the ICT Enabling Infrastructure support K-Adv by → | Developing an appropriate software and hardware infrastructure | Providing a proactive support for the ‘people’ and the ‘systems’ aspects of ICT. |

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| | | |
|--|--|---|
| Inactive AWARENESS | Very low availability, functionality and reliability (20% <), very old version of h/w (5 yrs); No sharing of s/w. Incompatible packages used; Use of discs/CDs for data transfer; Phone and paper used with supply chain; No access records or controls. | Poorly resourced help facility; Small number of tutorials or manuals; Unaware of CoP; Mutual mentoring on problems; Sporadic and crisis-based T&D; Minimal external T&D; User needs not defined; No emergency procedures; Systematic storage or security not planned. |
| Pre-active INITIATION | Low availability, functionality and reliability (40% <); Old version of the h/w(3-5 yrs); s/w Compatibility & h/w connectivity for one site only; Only standard applications; Low bandwidth connections; Password access, but no tracking. | Centralised help facility (e.g. call centre); Web enabled resources (e.g. FAQs); Wary approach to CoPs; Rigid T&D (eg on-line tutorials); Focus on current needs; Inconsistent support to BUs; Local focus on h/w & s/w synchronisation; Global access to archives. |
| Active ADOPTION | Medium Availability, Functionality And Reliability (60%<); H/W Lags By (~3yrs); Task Specific S/W Eg. Estimating; Cross Projects Interoperability; Servers With Emails; Moderate Bandwidth; Web Applications; Graded access. | Almost adequate resources and feedback; Well-resourced web and on-line help; Passive encouragement to CoPs; Network support and Training reactively driven by the BU needs; Planned, not necessarily current retrieval system; Structured access to archives; |
| Pro-active ACCEPTANCE ADAPTATION + | High availability, functionality and reliability, (90%<); h/w lag (3yrs); Web based s/w for policy and knowledge; B2B links with supply chain; Hardwired groupware and utilities; High security systems. | On-line and staff-based diagnostic support; Chat rooms to integrate CoPs; Mentoring & experiential learning supported; Life-cycle planning & h/w-s/w harmonisation at organisational level; Well-indexed and needs based archival systems. |
| Embedded ROUTINISATION + INFUSION | 24/7 availability, 100% functionality and reliability; h/w lag (1<yr); Network integrates supply chain; Active interaction; Wireless access; ERP systems; Video conferencing; Full tracking of security. | 24/7 expert help systems; Industry-based CoPs; Proactive T&D plans with links to education; ‘Scenario planning’ for future needs; Proactive approach to technology; System synchronised with supply chain; Flexible & seamless access to archival systems. |

Using the K-Adv framework it is possible for organisations to assess from the series of CMM tables for each K-Adv element, a picture of what the organisation’s current CMM position is and where it would like to be at a future time ‘t’. This enables gap analysis to take place and from that, the organisation can develop a strategy to improve KM practices that will enhance its K-Adv.

Many organisations are searching for ways to leverage the knowledge that they already have and thus sustain a high rate of continuous improvement. The optimum outcome is to create a combination of practices that is difficult to emulate. Another Chinese proverb from the “The Art of War” (Sun and Clavell, 1983) states - 三軍未動,糧草先行 (san jun wei dong, liang cao xian xing) This means that prior to engaging in any warfare; chariots, horses, belted armour and other provisions have to be made before troops can be raised. Even though an organisation may understand the benefits of knowledge management as a useful weapon to be use against its competition, and it may work actively to sharpen its

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own K-Adv, its ability to effectively use its software and hardware may still be immature. Effective KM depends upon sound use of ICT infrastructure facilities; one of the useful ICT tools that can support people and KM practices is an ERP system. ERP systems are probably the most rapidly growing corporate IT applications area operations today, thousands of companies have implemented them or are in the process of implementing ERP systems (Akkermans, Bogerd, Yucesan and van Wassenhove, 2003).

However, either general ICT or specific ERP investment decisions are not only about budgets and financial considerations but also about people. Investment in ICT will only add value if resources are managed in a way to support the business needs, motivate employees and give organisation the agility needed to respond to the business and market conditions. In the context of China, research indicates that successful implementation rate of ERP systems is low, with many organisations not achieving their intended goals (Zhang, Lee, Huang, Zhang and Huang, 2005). This research revealed that there is a large difference of ERP system implementation success rates between Western countries and China. The success or failure of the ERP systems may be affected by the interest and concerns of stakeholder not being properly addressed.

Stakeholders, those having a stake in the success of an endeavour, would include not only sub-contractors, suppliers, consultants and the client, but also project team employees (Bourne and Walker, 2005). Thus, in order to obtain ERP system success, organisations should take into account their organisational culture, as well as that of groups that they interface with, when taking an ERP system implementation decision. The intention of the use of ERP is to streamline and standardise procedures, to reduce duplicate administration costs, facilitate better decision making through better information flows and improve cost reporting and estimating (Al-Mashari *et al.*, 2003). The ultimate goal is to increase profitability and give an organisation a competitive advantage. ERP systems can ease access and extraction of information through a common platform within the organisation; however this function highly depends on the operational staff updating required data to enable the ERP system to work. Operational staff, managers and directors are all stakeholders but some frontline staff may find it difficult to input data on time leading to their interests not being met. Stakeholder management thus becomes more complex. Organisations who believe that the “only” stakeholders of interest are those people that invest in the organisation (with others being given a lesser status) are adopting a short sighted business success view. While each organisation needs to continue with its core business to generate revenue, it needs to engage, in many cases, with a large range of stakeholders. There is a need to create, maintain and manage a relationship with these people to ensure that ERP systems in fact achieve success (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003; Zhang *et al.*, 2005).

It can be seen from the above that a wide range of perspectives exists with which to study the effectiveness of ERP system implementation. One of the authors is employed with a major Hong Kong contractor that uses an ERP system and; this company provided an ideal opportunity, as part of a doctoral

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study, to conduct research to investigate how the ERP system was being implemented—more specifically the drivers and inhibitors that determine successful adoption and use of the system. Case study research allows for a great deal of depth and richness of data to be gathered to facilitate improved refinements and understanding of underlying theory (Eisenhardt, 1989). Part of the doctoral thesis research questions related to this paper are presented in

Table 2.

Table 2 - Research Questions

| Q# | Question |
|----|---|
| 1 | What are the principal drivers and inhibitors influence the successful implementation of ERP systems in the case study organisation? |
| 2 | How do these factors present themselves at the selected target group (the cost management business unit level in the Hong Kong head office) context? |
| 3 | At what level of capability maturity for deploying the ERP system is this case study target group currently positioned (question 3a) and would like to be positioned at a specified agreed future time (question 3b)? |
| 4 | What is the gap between the current and desired future position? |
| 5 | What actions need to taken to bridge that gap? |
| 6 | What is the priority of actions given expected support and contextual issues? |

The research project will involve a change management process being undertaken, using an action learning approach, based upon action resulting from answers to these questions. This involves the researcher working with the target team to undertake actions that will be planned, undertaken, reflected upon, and reviewed by the target group and the researcher and the cycle repeated until the desired outcome is substantially achieved at an agreed saturation level of effort for progress towards the goal (Smith, 2001; Zuber-Skerritt, 2002; Smith and O'Neal, 2003). The scope of this paper, however, is limited to the quantitative research pilot study that addresses questions 1-3 in

Table 2.

Research Approach

The first stage of this research project is reported upon in this paper. This entailed selecting a random sample of representative respondents from the target organisation and conducting a pilot survey of their opinion of the impact of factors associated with implementing the ERP system generally in the organisation in Hong Kong. Questions asked were based upon the literature and the CMM model developed by Walker *et al.* (2004). This provided a reasonable basis to understand the scope and scale of respondents' satisfaction and their attitude towards benefits and hindrances to using the ERP system. This pilot survey also highlighted potential problems associated with deploying the innovation. With the sub-text of the situation partially explored and exposed enough to proceed with an in-depth study using a specific target group, the next stage can proceed. The research approach is illustrated in Figure 3.

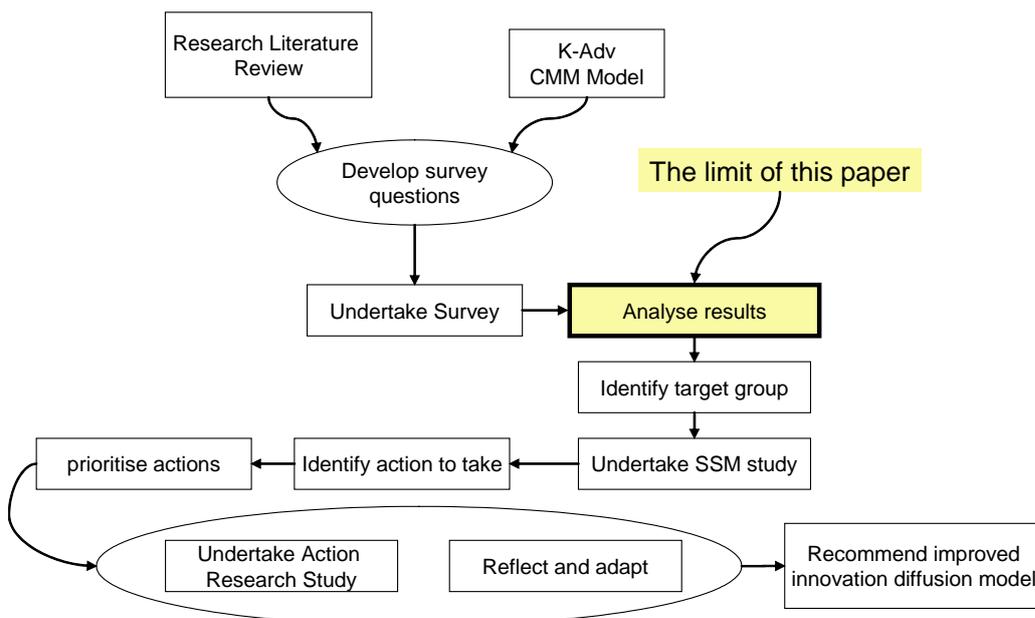


Figure 3 - The Research Approach

Triangulation was designed into the research approach in a number of ways. First, the literature provides a general view across disciplines and industries. This review helps to answer research question 1. Details of the K-Adv CMM tool developed by Walker *et al.* (2004) informed the nature of questions that could be asked in a pilot study to address research question 2. The aim of the pilot study was to expose underlying drivers and inhibitors and to test where the organisation in general is situated in a CMM. The wider aim of the exercise was first to select a willing critical group whose use of the ERP could benefit the firm's business performance. As one key element of firm's success is profitability then improvement in cost control that reduces waste (cost) and enhances revenue then the cost control function of the firm suggests itself as an appropriate business unit to study. A useful KM tool that can be deployed to better understand complex situations is soft systems methodology (SSM) (Maqsood, 2006). SSM is a 7-stage research process where complex and rich contextual issues are exposed and studied. It is beyond the scope of this paper to explain this process further, however interested readers can learn more from (Checkland, 1999) and how it has recently been applied in a construction context from Maqsood, Finegan and Walker (2006). One of the key elements of SSM is developing rich pictures that are developed jointly between the researchers and subjects to better understand complex situations. These lead to developing an ideal situation and gap analysis to identify actions that can be taken to improve a current situation to move it towards the idealised situation. Further, by using gap analysis to position a group on a CMM such as that illustrated in Table 1 actions can be recommended for improvement in making a change using the SSM study together with a CMM approach see (Walker, Maqsood and Finegan, 2005). The use of SSM and CMM provides a third part of the triangulation required for a rigorous study. In addition to this, the action part of the outcome from the SSM and CMM study results in a series of recommendations being undertaken and an action learning approach in which the researcher is an active and facilitating member is entirely appropriate (Coghlan, 2001; Coghlan and Brannick, 2005).

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Not all actions that can and should be undertaken are feasible so choices have to be made. A stage of the research design allows for participants in the study to prioritise the actions to be taken based upon what is doable and what is likely to be most effective. These actions will then be undertaken and intensely studied in a cycle that ceases at a saturation point when additional refinement efforts for improvement yield little additional improvement (Zuber-Skerritt, 2002). This end stage should allow the target group to achieve their stated preferred position on the CMM within their idealised timeframe. Further, the experience would lead to conclusions being drawn on how the organisation and the business unit can tackle other prioritised improvement actions and offer a model for the firm as a whole to consider. These steps would answer questions 3-6.

The following section and analysis will be limited to the pilot study as this is the only stage presently completed.

The Pilot Study and Case Study

ERP systems are expensive and complex and present a significant challenge to implement. Organisations that implement these would have built absorptive capacity through previous experience. Cohen and Levinthal (1990) define absorptive capacity as the ability of a firm to recognise the value of new external information, assimilate it and use it for commercial ends. It is a measure of an ability to absorb ideas, information and knowledge. It applies to both external and internal sources of information and knowledge. In undertaking a study of ways in which to improve ERP system implementation it makes sense to select an organisation that has considerable experience with implementing IT and ICT. The case study organisation fits that specification. It is a major Hong Kong contractor and has been operating since 1967. A more detailed description of the organisation follows.

A case study, based upon the experience of this leading construction company in Hong Kong, was chosen to demonstrate the effectiveness of KM in implementing an ERP system from the perspective of a cost management business unit. The research method used both quantitative and qualitative methods. A pilot study survey instrument was developed and administered with most questions requiring a categorical response (See Appendix 1) and several open-ended questions requiring a qualitative response (opinion). The scope of the pilot study was to develop and undertake a survey, based upon questions developed from the literature and personal experience of issues faced by the target organisational unit and by one of the researchers. Preliminary open ended discussion with colleagues unearthed issues identified in the literature that appeared to be relevant to the study. The purpose of this pilot study was to gather data about perceptions of the way that the ERP system has been functioning to supplement data that was also to be gathered from observation, unstructured interviews and to lead to a soft systems methodology (SSM) (Checkland, 1999; Walker, Finegan and Maqsood, 2003; Maqsood, 2006) study of the target group implementing the ERP system. Figure 3 illustrates the approach adopted for the doctoral study and

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how this pilot stage fits into that process.

Case Study Details

As one of the leading construction companies in Asia, the organisation's activities span the entire spectrum of building, civil engineering, foundation work, electrical and mechanical works as well as construction services. This organisation employs approximately 2,000 full-time staff, more than 50% of whom have a diploma or higher academic qualification, including 450 professional engineers and builders. This is one of the strongest and most experienced technical teams in Asia. The studied organisation has been building a wide range of construction projects in Asia for more than 45 years and is one of the Hong Kong market's leading construction contractors. .

The Company's headquarters are in Hong Kong and it operates throughout Mainland China and Southeast Asia. A detailed organisational structure chart of the organisation is as below Figure 4:

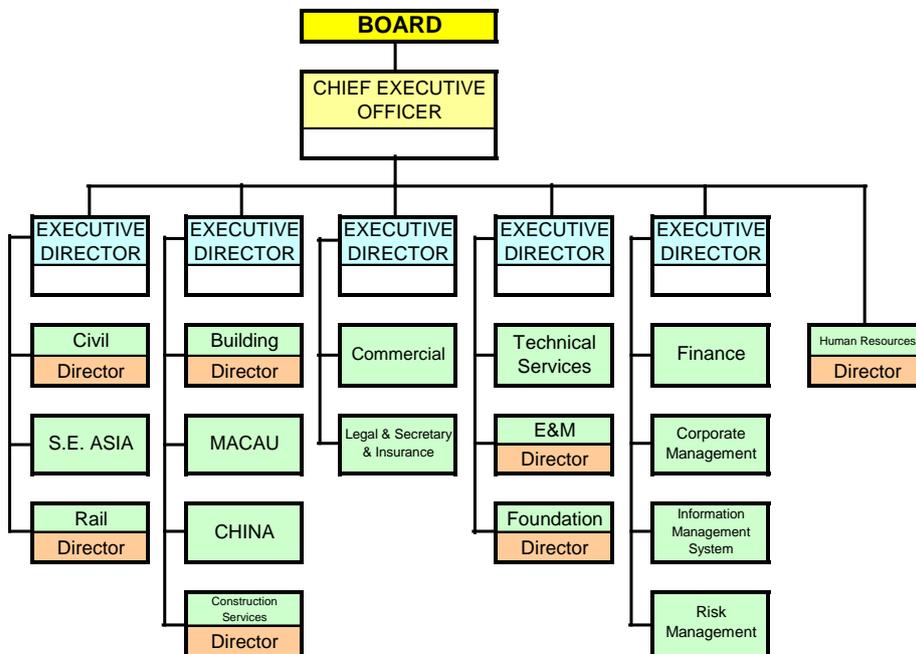


Figure 4 - Organization Structure the Case Study Organization

The organisation's culture indicates that it appreciates the importance of KM. The company's ethos reinforces an attitude that it is unwise to compete with others by purely cutting costs and compromising quality, rather, it is more effective to sharpen its own knowledge advantage to derive a differentiate itself based upon a service quality and effectiveness (rather than cost-efficiency) competitive advantage.

Effective KM, however, depends in part upon sound use of ICT infrastructure (Walker, 2005). In early 2001, the organisation started to consider using an ERP platform for its ICT infrastructure to enhance its information management as part of its broader KM strategy. Through use of the ERP system, different

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parts of the organisation aimed to use configurable information systems packages that integrate information and information-based process within and across-functional areas. The design and objective of the ERP system was one of “bridging” and “bonding” parts of the organisation’s information and knowledge resources. In terms of “bridging”, different departments are linked by an ERP system that facilitates developing a common ICT infrastructure for the benefit of integrating diverse business activities to enhance information flow. The system’s design facilitates existing organisational process and allows possible improvements to be made to increase diffusion of information throughout the partner organisations. With respect to “bonding”, it is intended to discourage self-interest dominating over collective interest through facilitating more effective knowledge sharing and joint decision making using the ERP system as a platform for creating, sharing and processing information and storing and archiving data, information and codified knowledge. It is intended that the ERP system help to link people together to create internal bonds within the team that must be forged before embarking on integration of diverse organisational knowledge sets.

The aim of deploying the ERP system was to streamline and standardise procedures, to reduce duplicate administration costs, facilitate better decision making through better information flows and improve reliability of cost reporting and estimating. The ultimate goal was to increase profitability by enhancing efficiency, reducing head count and overhead expenses and paper work procedures. The organisation decided to purchase two separate licences of “off-the-shelf-software” ERP packages and employ an external consultant to customise it to suit the estimating, tendering and cost management requirements of the organisation. Whilst an external consultant was employed, the organization understood the need for internal support and knowledge transfer and hence internal staff were seconded to the project in order to form a working group that was able to deal with the design and implementation of the ERP systems. A new project manager with strong IT background was employed to lead the team. Internal ICT staff were responsible for ICT matters including modifications to the base functionality as well as operational needs such as software deployment, personal computer inventory and required upgrades, technical architecture, systems support and maintenance, infrastructure design and overall training. The responsibility of the project team was to: provide information; practitioner knowledge, which included activity and work flow of the existing system; identification of changes to the existing processes and operational requirements; confirm users and assist in their training; and prepare data for conversion and transition.

Figure 5 illustrates the intended implementation strategy. External consultants were appointed to provide explicit knowledge and how to customise the ERP system. Organisational IT support staff worked with the external consultants to customise the ERP system with cost management staff so that both internal staff could use a combination of explicit procedural knowledge as well as tacit knowledge about the way that the organisation’s functional activities ‘worked’ as well as cultural and contextual tacit knowledge necessary to ensure successful implementation. These three groups were also involved in experimental knowledge generation in refining and customising the ERP system as well as on the job informal and

formal training and knowledge development activities.

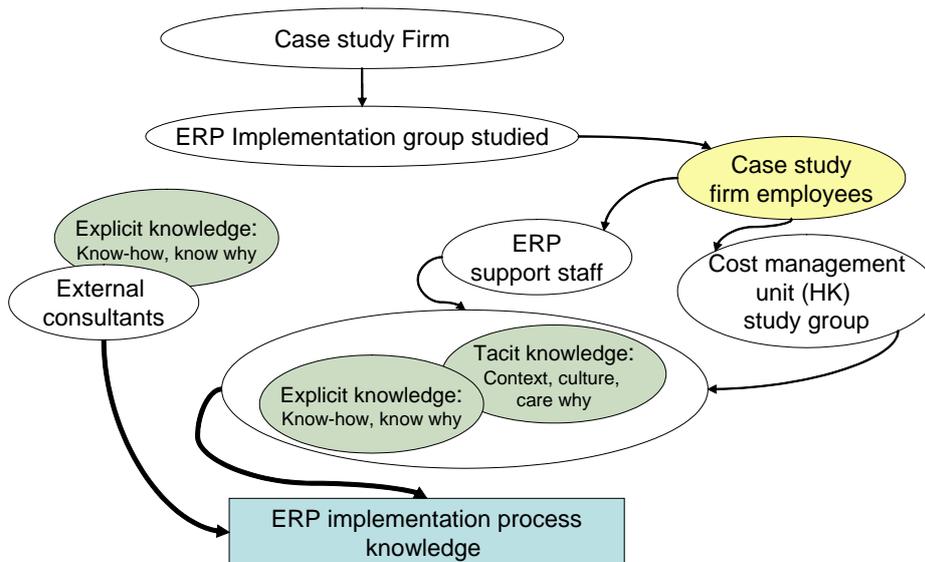


Figure 5 - Case study organization ERP Implementation Strategy

The ERP system was put into operation during December 2002. The organisation was thus the focus of the case study and its cost management group in Hong Kong implementation was the unit of analysis. A qualitative approach to the collection of data was adopted. The reason for choosing this approach is because, according to (Glesne and Peshkin, 1992), this is appropriate to serve the purpose of “interpretation”, which enables researchers to gain insights about a particular phenomenon and discover problems that exist within the phenomenon. The first stage of this qualitative study used: a questionnaire (see Appendix 1) that was developed from the literature review; discussion with several participants from the organisation that were intimately involved with the ERP implementation: and the researcher’s own experience. According to (Mowery, Oxely and Silverman, 1996), questions are related to facts, people’s beliefs and perspectives about facts, feelings, motives, present and past behaviours, standard for behaviours, conscious reasons for actions or feelings.

The target organisational cost management unit had a population of about 200 people with 50 potential respondents from ICT staff, senior management and operational staff as at the May 2006 time when the survey was administered. Staff were asked to voluntarily participate and complete the survey questionnaire. Of the 50 staff that could potentially take part in the survey, 18 were approached and agreed to respond. The choice of this group was determined on: willingness to participate in the research together with their special characteristics to ensure that perspectives gathered from the research would be balanced and as comprehensive as possible.

The survey (See Appendix 1) was divided into nine distinct sections:

Section 1: Respondents’ Profile

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Section 2: ERP Solution

Section 3: Factors Considered in Implementing the ERP

Section 4: Areas of ERP Implementation

Section 5: Consultant/trainer on the ERP implementation

Section 6: Problem Areas on ERP Implementation

Section 7: Effects on the ERP Solution

Section 8: Impact of the ERP implementation on the organisation's productivity

Section 9: Other applications of ERP

The first section asks general demographic questions relating to the respondents' position, department and working experience in the organisation. The second section asks directly for respondent's perception and expectation of the ERP system. In Section 3, questions were developed asking respondents' opinion factors considered in ERP implementation. The fourth section asks the respondents to rank the performance of areas of ERP implementation. The fifth section collects opinions about the reasons for hiring or not hiring ERP system consultants/trainers. The sixth section asks questions about problem areas of ERP implementation where improvement may be required. The seventh section asks respondents to rate the ERP performance. The eighth section seeks opinions about the impact of the ERP implementation on the organisation's productivity. Finally, respondents are prompted to suggest further ERP system applications.

The length of the questionnaire was kept as short as possible, with the entire questionnaire able to be completed within 20 minutes. Views and opinions from a range of construction practitioners in the organisation were sought. Most participants are team members of past and current projects of the organisation where one of the authors currently works, however these participants are not directly accountable to him. Confidentiality was maintained through using pseudonyms or a job position and not referring to them by name i.e. Respondent 1 and so on. The questionnaire was sent by e-mail to participants within the organisation.

Results and Findings

Eighteen survey responses were received and the results analysed under the following headings:

- Respondents' profile;
- Respondents' perceptions of what an ERP system theoretically delivers;
- Respondents' expectations of what the ERP system will deliver;
- Factors considered in the ERP system implementation;
- Implementation performance areas;
- ERP system implementation problem areas;
- ERP system effectiveness;
- Impact of ERP system implementation on the organisation's productivity; and

- Suggestions for incorporating other ERP system applications.

Respondents' Profile

Table 3 - Respondents' Characteristics

| Profile | A | B | C | D | IT | Finance | Commercial | M | F | Manager | Officer | Staff | Managing QS | Senior Systems Analyst | Senior Quantity Surveyor | Senior Project Quantity Surveyor | Project Quantity Surveyor | Quantity Surveyor | Senior Accounts Clerk | Accounting Supervisor | Site Administrator | <10 | >10 |
|----------------------|---|---|---|---|----|---------|------------|----|---|---------|---------|-------|-------------|------------------------|--------------------------|----------------------------------|---------------------------|-------------------|-----------------------|-----------------------|--------------------|-----|-----|
| Age | 3 | 6 | 6 | 3 | | | | | | | | | | | | | | | | | | | |
| Department | | | | | 2 | 5 | 11 | | | | | | | | | | | | | | | | |
| Gender | | | | | | | | 13 | 5 | | | | | | | | | | | | | | |
| Grade | | | | | | | | | | 4 | 8 | 6 | | | | | | | | | | | |
| Position | | | | | | | | | | | | | 1 | 2 | 1 | 4 | 2 | 3 | 1 | 1 | 3 | | |
| Year in Organisation | | | | | | | | | | | | | | | | | | | | | | 7 | 11 |
| Grand Total | 3 | 6 | 6 | 3 | 2 | 5 | 11 | 13 | 5 | 4 | 8 | 6 | 1 | 2 | 1 | 4 | 2 | 3 | 1 | 1 | 3 | 7 | 11 |

Age: (A)below 30; (B)30-35;(C)35-40;(D)above 40

Table 3 illustrates that most of the respondents are Quantity Surveyors (including Managing Quantity Surveyor, Senior Quantity Surveyor, Senior Project Quantity Surveyor, Project Quantity Surveyor and Quantity Surveyor) while Senior Accounts Clerk and Accounting Supervisors are fewer in number. Six are operational staff, eight are senior officers or officers, and four are managers. Eleven respondents work in the commercial department, five from finance and two from IT. With regards to age, three were below 30 years old, twelve between 30 to 40 years old and three over 40 years old so this provides an idea of potential computer literacy because most workers in their earlier careers will have had more extensive exposure to using IT in their education and work experience and are thus likely to be more IT literate. Furthermore, thirteen males and five females comprise the group. Eleven respondents have been working in the organisation for over ten years and seven less than ten years. This represents an average number of 11.61 or approximately 12 years employment tenure.

Respondents' perceptions of what an ERP system theoretically delivers

Peansupap and Walker (2005) identify that users' perceiving benefits from the ICT system to be introduced is a significant factor for successful ICT diffusion. The majority of respondents saw the ERP system as an effective and accurate tool that should provide authorized people with real time on-line cost data information. Also, since cost data are provided on-line, then it is made available to various departments who need it concurrently and could also be made available in hard copy format. Hence, there is perceived increased organisational efficiency.

ERP cost analysis reports are generated in the desired format with more flexibility. At any given period, forecast and actual financial data can easily be compared. Cost review and control is moreover easily managed and ledgers can be more efficiency updated. Cost data are integrated into a common platform, which in turn makes data sharing among departments more systematic.

The ERP system therefore modernizes and standardizes business processes among departments in the organisation since cost data is monitored and controlled in the most efficient and accurate manner.

Respondents' expectations of what the ERP system will deliver

The respondents were able to compare their perceptions of the ERP system actual delivery with their own expectations of the system. In general, respondents' perceptions were that the ERP system will improve cost data control and management. Their expectations are summarised as follows.

First, respondents expected that the workload of various officers in the department who are in-charge of managing and monitoring cost data would be reduced. Since data is supposed to be available on-line, then it should also be possible for authorized individuals to access databases without difficulty of having to translate data into the ERP system standard format. Information was also expected to be delivered accurately and on time. Reports should be easily generated by different departments and that this should enable quick cost checking and cost data monitoring. Data should be easily updated and provide procedural transparency since data should be made available to authorised people in the organisation. Filing space should be reduced—on-line information retrieval should create a paper-less office.

With much of the routine information and data processing being handled electronically by the ERP system, this should release people to engage more fully in KM activities such as anticipating and proactively problem-solving and more effectively contextualising information and transferring knowledge and using knowledge to improve the way that work is undertaken.

Factors considered in the ERP system implementation

A literature review revealed six key factors considered as relevant to the organisation that were believed to affect ERP implementation and these were included in the questionnaire. Respondents were asked to rate each of these factors according to the degree of importance (with 1 as very important, 2 as moderately important, 3 as less important, 4 as not important and 5 as not relevant).

Table 4 - Factors considered in implementing ERP

| Factors | in No. | | | | | Total | in Percentage | | | | |
|---------------------------------------|--------|----|---|---|---|-------|---------------|-----|-----|-----|----|
| | Scale | | | | | | Scale | | | | |
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Modernize the IT environment | 3 | 10 | 4 | 1 | 0 | 18 | 17% | 56% | 22% | 6% | 0% |
| Replace obsolete systems | 5 | 10 | 1 | 2 | 0 | 18 | 28% | 56% | 6% | 11% | 0% |
| Efficiency | 14 | 4 | 0 | 0 | 0 | 18 | 78% | 22% | 0% | 0% | 0% |
| Provide better management tools | 10 | 8 | 0 | 0 | 0 | 18 | 56% | 44% | 0% | 0% | 0% |
| Increase customer satisfaction | 6 | 5 | 5 | 1 | 1 | 18 | 33% | 28% | 28% | 6% | 6% |
| Increase organisation competitiveness | 9 | 8 | 1 | 0 | 0 | 18 | 50% | 44% | 6% | 0% | 0% |

Table 4 indicates that respondents feel that efficiency is very important and is the most critical reason (factor) for ERP system implementation. Survey results also reveal that respondents believe that ERP system implementation can increase organisational competitiveness.

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Implementation performance areas

Respondents were further asked to rate the ERP system with respect to its performance in thirteen areas of implementation. The ratings range from 1 to 5 with 1 as excellent, 2 as satisfactory, 3 as cannot determine, 4 as fair and 5 as poor.

Table 5 - Areas of ERP implementation (performance)

| Areas | in No. | | | | | Total | in Percentage | | | | |
|---------------------------|--------|----|---|---|---|-------|---------------|-----|-----|-----|-----|
| | Scale | | | | | | Scale | | | | |
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Software Package | 0 | 13 | 1 | 2 | 2 | 18 | 0% | 72% | 6% | 11% | 11% |
| Project Control | 3 | 13 | 1 | 1 | 0 | 18 | 17% | 72% | 6% | 6% | 0% |
| Project Budget | 1 | 8 | 4 | 5 | 0 | 18 | 6% | 44% | 22% | 28% | 0% |
| Project Schedule | 1 | 5 | 7 | 5 | 0 | 18 | 6% | 28% | 39% | 28% | 0% |
| Project Scope | 3 | 3 | 8 | 4 | 0 | 18 | 17% | 17% | 44% | 22% | 0% |
| Project Management | 1 | 6 | 8 | 3 | 0 | 18 | 6% | 33% | 44% | 17% | 0% |
| Communications | 6 | 6 | 3 | 3 | 0 | 18 | 33% | 33% | 17% | 17% | 0% |
| External Consultants | 0 | 1 | 7 | 4 | 6 | 18 | 0% | 6% | 39% | 22% | 33% |
| Internal Team | 0 | 5 | 8 | 5 | 0 | 18 | 0% | 28% | 44% | 28% | 0% |
| Training Process | 1 | 14 | 2 | 0 | 1 | 18 | 6% | 78% | 11% | 0% | 6% |
| Technology Infrastructure | 0 | 8 | 4 | 6 | 0 | 18 | 0% | 44% | 22% | 33% | 0% |
| Process Redesign | 1 | 9 | 3 | 5 | 0 | 18 | 6% | 50% | 17% | 28% | 0% |
| Customization | 1 | 5 | 4 | 7 | 1 | 18 | 6% | 28% | 22% | 39% | 6% |

Table 5 indicates that the respondents think that the ERP system will promote excellent project control and communications performance. However, a few respondents could determine whether the ERP system would result in excellent or poor project schedule, scope and management performance or improvement in external consultants and internal team performance. However, all respondents reported that their organisation provided an ERP system implementation consultant or trainer to help them. ERP system implementation was thus facilitated by consultants/trainers providing training, introducing ERP system functions, helping them to smoothly operate the ERP system, train the internal trainer, standardize the customers' ERP system implementation, and to provide a backbone ERP system infrastructure platform .

ERP system implementation problem areas

Seventeen ERP implementation problem areas were identified and respondents were asked to rate each area according to the extent of their agreement of disagreement. They were asked to choose from 5 options with 1 as agree, 2 as partly agree, 3 as cannot determine, 4 as partly disagree and 5 as disagree. _

Table 6 - Problem areas on ERP implementation

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| Problem Areas | in No. | | | | | Total | in Percentage | | | | |
|--|--------|----|----|---|---|-------|---------------|-----|-----|-----|-----|
| | Scale | | | | | | Scale | | | | |
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Technical issues | 8 | 8 | 0 | 2 | 0 | 18 | 44% | 44% | 0% | 11% | 0% |
| Organizational Issues | 9 | 7 | 1 | 1 | 0 | 18 | 50% | 39% | 6% | 6% | 0% |
| Data Issues | 12 | 5 | 0 | 0 | 1 | 18 | 67% | 28% | 0% | 0% | 6% |
| Vendor not delivering promised functionality in a timely fashion | 3 | 6 | 8 | 0 | 1 | 18 | 17% | 33% | 44% | 0% | 6% |
| Lack of financial resources | 7 | 4 | 3 | 3 | 1 | 18 | 39% | 22% | 17% | 17% | 6% |
| Training Issues | 13 | 2 | 0 | 2 | 1 | 18 | 72% | 11% | 0% | 11% | 6% |
| Lack of internal expertise | 10 | 4 | 2 | 1 | 1 | 18 | 56% | 22% | 11% | 6% | 6% |
| Lack of consensus among the business owners | 5 | 7 | 3 | 2 | 1 | 18 | 28% | 39% | 17% | 11% | 6% |
| Lack of consensus among the institution? senior management | 11 | 2 | 4 | 0 | 1 | 18 | 61% | 11% | 22% | 0% | 6% |
| Quality of the software | 10 | 7 | 1 | 0 | 0 | 18 | 56% | 39% | 6% | 0% | 0% |
| Lack of understanding on the capability of the software | 6 | 10 | 0 | 2 | 0 | 18 | 33% | 56% | 0% | 11% | 0% |
| Inadequate training | 9 | 6 | 0 | 3 | 0 | 18 | 50% | 33% | 0% | 17% | 0% |
| Inadequate communications strategy | 5 | 3 | 10 | 0 | 0 | 18 | 28% | 17% | 56% | 0% | 0% |
| Resistance to change | 14 | 4 | 0 | 0 | 0 | 18 | 78% | 22% | 0% | 0% | 0% |
| Alignment between software and business process | 13 | 3 | 1 | 0 | 1 | 18 | 72% | 17% | 6% | 0% | 6% |
| Customizations | 6 | 5 | 7 | 0 | 0 | 18 | 33% | 28% | 39% | 0% | 0% |
| Issues in working with external consultants | 4 | 3 | 5 | 4 | 2 | 18 | 22% | 17% | 28% | 22% | 11% |

Table 6 provides an overview of the responses relating to organisational and data issues, such as lack of financial resources, training issues, lack of internal expertise, lack of consensus among the institution's senior management, quality of the software, inadequate training, resistance to change and alignment between software and business process being a hindrance to effective ERP system implementation. Most agreed that these issues presented problems in effectively implementing the ERP system. Others partly agree that technical issues, lack of consensus among the business owners and lack of understanding on the capability of the software are also ERP system implementation problems. A number of respondents could not determine whether these ERP system implementation issues are problems or related to: vendors not delivering promised functionality in a timely fashion, inadequate communications strategy, customization, and issues in working with external consultants. One respondent further added that one possible ERP system implementation problem is that reports turn out to be inaccurate at times, even after people have worked long hours entering data.

ERP system effectiveness

This study also rated ten areas where effectiveness has been; 1 increased, 2 partly increased, 3 constant, 4 partly decreased, and 5 decreased.

Table 7 - Effects on the ERP solution

| Effects | in No. | | | | | Total | in Percentage | | | | |
|-----------------------------------|--------|----|---|---|---|-------|---------------|-----|-----|-----|-----|
| | Scale | | | | | | Scale | | | | |
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| Staff/personnel | 7 | 9 | 1 | 1 | 0 | 18 | 39% | 50% | 6% | 6% | 0% |
| Packaged software | 6 | 7 | 5 | 0 | 0 | 18 | 33% | 39% | 28% | 0% | 0% |
| Database | 6 | 4 | 5 | 1 | 2 | 18 | 33% | 22% | 28% | 6% | 11% |
| Internal applications and code | 5 | 6 | 2 | 5 | 0 | 18 | 28% | 33% | 11% | 28% | 0% |
| Hardware and infrastructure | 4 | 7 | 6 | 1 | 0 | 18 | 22% | 39% | 33% | 6% | 0% |
| Desktop products and services | 9 | 3 | 6 | 0 | 0 | 18 | 50% | 17% | 33% | 0% | 0% |
| Training | 11 | 7 | 0 | 0 | 0 | 18 | 61% | 39% | 0% | 0% | 0% |
| Help desk and user support | 10 | 7 | 1 | 0 | 0 | 18 | 56% | 39% | 6% | 0% | 0% |
| Systems operations and management | 6 | 11 | 1 | 0 | 0 | 18 | 33% | 61% | 6% | 0% | 0% |
| Consulting | 5 | 10 | 2 | 1 | 0 | 18 | 28% | 56% | 11% | 6% | 0% |

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Table 7 indicates that staff or personnel effectiveness in using ERP systems has partly increased. The same result was found for packaged software use, internal applications and code, hardware and infrastructure, systems operations and management and consulting. The organisation's database, desktop products and services, training as well as help desk and user support, were found to have a stronger increased effectiveness through using the ERP system. However two respondents commented that the ERP system led to total administration costs increasing due to license fees, hardware, training and implementation and organisations spend more time in managing data in using the ERP system.

Impact of the ERP system implementation on the organisation's productivity

The implementation of the ERP system did not appear to have a consistent positive impact on the organisation. Some respondents reported positively while others indicated several disadvantages. Updated financial information is provided on-line by the ERP system, so a broader base of information is quickly made available to people who may need it. Reporting, planning and decision-making is made easy because needed information is immediately updated. Also, better communication is established among departments. Transparency in the organisation is improved and work is undertaken more efficiently. Working procedures and processes can be redesigned to fit organisational needs. However, some respondents reported that the ERP system implementation resulted in on-site increased workload levels. They is also reported increased data entry as well as data verification workload. One respondent stated that the support software always had errors and therefore significantly impaired work process effectiveness with generated reports being useless to the organisation.

Suggestions for incorporating other ERP system applications

Some respondents suggested that, ERP applications should include export and import of data from one software package to another as well as the inclusion of a data search function. Data analysis could include costs estimation to be performed using the system as well as stock control and planning and tracking procurement flow. They also suggested that a centralized database should also be provided.

Discussion and Conclusions

Discussion of The ERP System Objectives

According to (Davenport and Prusak, 1998) KM involves creating, sharing, disseminating, and utilizing knowledge data within organisation. The survey results indicate that a majority of the respondents identify that the ERP system can effectively and accurately manage cost data in real time to allow people to engage in improved project cost control planning and decision making and storage and retrieval of information used for interpreting past actions. Thus the ERP system facilitates better knowledge management. Although the ERP system implementation does not appear to have a positive impact to the organisations all the time, respondents are able to equate their perceptions of their expectations of what the ERP solution should offer with their own experience of how the ERP system improves control and

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management of vast data bases of information that can be used to generate knowledge.

The intention of using the ERP system is to streamline and standardise procedures, to reduce duplication in administration costs, to facilitate better decision making through better information flows and to improve cost reporting and estimating (Al-Mashari *et al.*, 2003). From the literature review, there has been widespread acceptance that ICT is a key enabler of KM that enhances a firm's potential for gaining competitive advantage (Peansupap, 2004; Walker, 2005; Maqsood, 2006). As for those factors considered in the ERP implementation, the majority of respondents rate efficiency as the most critical factor and see providing better management tools as very important. These are in line with (Cleland, 1999) who argues that effective project cost management requires access to accurate, current, reliable data and information and is concerned with establishing processes to monitor and control budgets. According to (Walker, 2005), when KM is supported by an effective ICT infrastructure, it can facilitate competitive advantage. This argument is compatible with the perception expressed by respondents that the ERP system can increase the organisation's competitiveness.

An ERP system can ease access and extract information through a common platform within the organisation. However, there is a need to create, maintain and manage a relationship with users to ensure that these ERP systems successfully deliver their promised goals (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003; Zhang *et al.*, 2005). Most survey respondents agreed that communications performance was excellent after the ERP system was implemented. However, one-third of the respondents were dissatisfied with the performance of external consultants supporting the system. The majority of respondents agree that training and resistance to change are very important issues that external consultants could not significantly assist with resolving. People are best at transferring and reframing ERP system knowledge through personal interaction in groups that share trust and passion and are willing to volunteer this knowledge to each other. This is where communities of practice (COPs) can help people share knowledge and skills and help sustain its members through their obligation to exchange knowledge and provide access to shared insights about their work practice (Wenger *et al.*, 2002).

Other problems identified by the pilot survey relate to data issues and alignment between software and business process, which are in turn related to software quality. Respondents also expressed concern about the help desk and user support, desktop products and services and training, and its impact upon effective use of the ERP system. This is a stakeholder expectation management matter because of the need to create, maintain and manage a relationship with those people and groups with a stake to ensure the successful implementation of ERP system (Akkermans *et al.*, 2003; Al-Mashari *et al.*, 2003; Zhang *et al.*, 2005). This raises KM issues about the way that this ICT tool was deployed in the department studied and the pilot results indicate issues consistent with that raised by a recent study (Peansupap, 2004; Peansupap and Walker, 2005).

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Finally, some respondents suggest that further applications of the ERP system should be implemented, e.g. exporting and importing data amongst different software; data analysing for estimation; stock controlling etc. This provides an encouraging and positive sign that people see the ERP system as a useful tool for sharing, disseminating, and utilizing data that can generate knowledge to facilitate sustainable competitive advantage.

Assessing the CMM of the Organisation

Table 1 in the literature review section, offers a CMM model to categorise an organisation's maturity level of the ICT enabling infrastructure that can support a K-Adv. Five levels are described below:

- Level 5: being inactive and only barely aware of a given aspect only;
- Level 4: being pre-active in terms of initiating plans for becoming active;
- Level 3: being active in adopting the particular elements;
- Level 2: being pro-active in accepting and adopting the approach, and then adapting it to suit the context and circumstances;
- Level 1: being embedded with the adaptation having become routine and infused as the natural way of doing things.

The organisation studied has actively invested significant resources for the ERP system implementation. The results of the survey indicates that many respondents in the organisation believe that the ERP system is capable of managing cost data and is able to match participant's perceptions of what the ERP system delivers—their expectations are for the system to improve, cost control and data management and the organisation considers efficiency as its most critical objective and feels that the ERP system can increase the organisation's competitiveness.

Evidence from the organisation's internal communication indicates that it believes that communication performance is excellent post ERP system implementation, and that training issues and resistance to change are very important issues yet to be fully resolved. Therefore, the organisation has actively engaged external consultants to provide staff training. The organisation understands the importance of effective help desk and user support, desktop products and services and training to effectively deploy the ERP system and has endeavoured to deliver this assistance. Adequate resources and feedback, on-line help, network support and training are however, reactively provided. Some respondents suggest applying further organisational business functions to the ERP system and this demonstrates that the organisation is actively promoting the ERP system as a tool to facilitate sustainable competitive advantage through improved information management leading to KM activities.

In comparing the survey results to different capability maturity levels for deploying the ERP system, the evidence indicates that the organisation has met the maturity Level 3. Table 1 states this level is characterised by "*almost adequate resources and feedback; well-resourced web and on-line help; passive*

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encouragement to CoPs; network support and training reactively driven by the BU needs; planned, not necessarily current retrieval system; structured access to archives". However, this is not enough for a market leader to be confident that it can retain its competitive position. The goal ahead should be to have a pro-active interaction and approach to technology, (characterised in Table 1 as including full tracking of security, and flexible and seamless access to archival systems). As far as the existing ERP system is concerned, it should be synchronised with other business functions e.g. integration with the supply chain system. To do this, the wider supply chain stakeholder's needs must be first identified. This would facilitate gap analysis to take place and from that, the organisation can develop a strategy to improve KM practices that will enhance its K-Adv across the organisation and its supply chain.

Conclusions

Good application of knowledge management (KM) puts the organisation into a potentially winning position. ICT tools can assist to manage information and knowledge data. An ERP system is a specific software tool used for cost management to help construction contractors better manages their cost data and to make improved cost management decisions. In terms of KM issues two aspects need to be addressed.

First, an ERP tool that is effectively deployed provides not only valuable information processing capability to better control costs but it can also help identify ways to be more effective in dealing with its supply chain partners as well as improve its internal cost management reporting and decision making. The pilot study results, based upon the experience of a leading construction company using an ERP system, demonstrates the potential effectiveness of an ERP system from a cost management business unit's perspective.

Second, in order to deploy the ERP system, this innovation must be effectively diffused. This ICT diffusion process at the ERP implementation stage itself involves a KM process. A CMM tool was used to indicate the level of effectiveness that this ICT innovation is being deployed at. The case study appears to be at a Level 3 (active adoption). Adequate resources and feedback; on-line help; help desk and user support and training have been provided by the organisation. In addition, the organisation believes that the ERP is capable of managing cost data and identify efficiency is their most critical factor to increase organisation's competitiveness. However, the capability of ERP seems to be under-utilized. The study also indicates that participants would prefer to operate at a high level. The CMM tool presented allows gap analysis to indicate what this high level of maturity might look like. The next step in the broader study that has yet to be undertaken, involves in-depth analysis through a SSM study to identify actions that can be implemented and evaluated.

Finally, in terms of the doctoral research project being undertaken by one of the authors, results from this pilot study is not generalized, it is nevertheless useful to provide valuable insights into the messy and

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complex people's personal experience trying to make use of this ERP system effectively. These insights will be more richly explored in the next research phase which will involve a SSM study being undertaken to unearth paradoxes and hidden problems and to identify how the KM process of diffusion and adoption of this innovation can be better deployed.

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Appendix 1 – The Survey Instrument

OBJECTIVE: The study aim is to determine the Enterprise Resource Planning (ERP) high level expectation and outcome for costing control function.

A. ERP Solution:

A1. What are your perceptions on the ERP solution for costing control function?

A2. What are your expectations on the ERP solution for costing control function?

B. Factors Considered in Implementing the ERP:

Rate according to importance (1=Important, 2=Not important, 3= Not relevant)

- B1. Modernize the IT environment
- B2. Replace obsolete systems
- B3. Efficiency (reduces cost, improve speed of process)
- B4. Provide better management tools in decision-making and planning
- B5. Increase customer satisfaction
- B6. Increase organisation's competitiveness
- B7. Others, please specify:

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C. Areas of ERP Implementation:

Rate according to performance (1 =Satisfactory, 2 =Not Satisfactory, 3 =Cannot Determine)

- C1. Software Package
- C2. External Consultants
- C3. Project Governance
- C4. Internal Team Structure
- C5. Project Budget
- C6. Training Process
- C7. Project Schedule
- C8. Technology Infrastructure
- C9. Project Scope
- C10. Process Redesign
- C11. Project Management
- C12. Software Customization
- C13. Communications
- C14. Others, please specify:

D. Have the organisation hire a consultant/trainer on the ERP implementation?

Yes No

E. What are your opinions about the reasons for hiring or not hiring consultants/trainers of the ERP?

F. Problem Areas on ERP Implementation:

Rate according to agreement (1=Agree, 2=Disagree, 3=Cannot Determine)

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- F1. Technical issues (hardware/database issues, scalability, systems integration)
- F2. Organizational Issues (governance issues, process redesign)
- F3. Data Issues (reconciling multiple data sources, ensuring data integrity)
- F4. Vendor not delivering promised functionality in a timely fashion
- F5. Lack of financial resources
- F6. Training Issues
- F7. Lack of internal expertise
- F8. Lack of consensus among the business owners
- F9. Lack of consensus among the institution's senior management
- F10. Quality of the software
- F11. Lack of understanding on the capability of the software
- F12. Inadequate training
- F13. Inadequate communications strategy
- F14. Resistance to change
- F15. Alignment between software and business process
- F16. Customizations
- F17. Issues in working with external consultants
- F18. Others, please specify:

G. Effects of the ERP Solution

Rate according to the degree of effect (1 = Increased, 2 = Decreased, 3 = Constant)

- G1. Staff/personnel
- G2. Packaged software (purchased products)
- G3. Database
- G4. Internal applications and code
- G5. Hardware and infrastructure
- G6. Desktop products and services
- G7. Training
- G8. Help desk and user support
- G9. Systems operations and management
- G10. Consulting
- G11. Others, please specify:

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G12. What is the impact of the ERP implementation on the organisation's productivity?

H. What are the other applications of ERP you think useful?
