If construction firms are to strategically acquire the full potential of IT then they must evaluate its direct and indirect benefits and costs prior to its implementation, as investments in IT can form a considerable part of a construction firms capital expenditure (Gyampoh-Vidogah *et al*., 1999). Because IT is considered to be a large capital investment many construction firms often find it difficult to justify its implementation due to their low profit margins. It is therefore essential for senior management to be sure that investments in IT are economically justifiable. Remenyi *et al*. (1998) suggests that managers typically justify their IT investments on an informal basis making judgements based on their own perceptions of potential costs and benefits. On a similar note Baldwin *et al*. (1999:p.289) suggest that "one of the biggest problems organisations have in making effective IT investments in construction is their inability to predict and measure the benefits that result".

This paper presents initial findings from an on-going research project that is developing cost and benefit taxonomies, which managers of construction firms can use for evaluating IT investments. Based on a review of the normative literature, an initial conceptual framework (CF) for IT evaluation is proposed. Findings from a case study are presented and discussed in the context of the CF.

2. IT INVESTMENT JUSTICATION

Most management executives are not comfortable with the available set of tools and techniques used to justify their investments in IT (Alter, 1999). Lefley and Sarkis (1996) proffer that investment justification processes used by management are typically based on the use of traditional appraisal techniques, which are inadequate for strategic decision-making. Such traditional techniques lack the preciseness in definition and results that management expect. Irani and Love (2000) have found that management tends to be myopic when considering IT investment decisions, primarily because they have no framework to evaluate their IT investment. In addition, management gives less attention to the 'hidden' or indirect costs surrounding IT, which can be up to four times greater than its 'direct' IT cost component (Hochstrasser, 1992). The implications of ignoring 'indirect' costs can have far-reaching consequences for construction firms. For example, reduced productivity because employees have not been sufficiently trained, and loss of employees to competitors, specifically competent CAD users. Li *et al*. (2000) suggests that many construction firms may only realise the significance of these additional cost factors once they have actually implemented an IT infrastructure. Fundamentally, poor IT decision-making can result in financial losses, which can translate into a loss in competitiveness, and even jobs! The costs associated with such losses are invariably passed on to the client and other members involved with the construction firm's business processes.

Research undertaken by Lefley and Sarkis (1997) found the process of investment justification was a major barrier to implementing IT in many companies. Primrose (1991) identifies the manufacturing industry's perception of investment justification as a budgetary process that gives a final 'yes' or 'no' – 'pass' or 'fail' verdict on the 'success' of a IT infrastructure proposal. Consequently, managers may view IT justification as a 'hurdle' that has to be overcome, and not as a technique for evaluating the worth of implementing IT. This has serious consequences, as during the preparation of an IT proposal, managers may spend too much time and effort investigating technical aspects of IT and thus become committed to the belief that from a technical perspective, the investment is essential. Moreover, managers may be easily susceptible to persuasion by software developers and consultants, and be prepared to accept untypical demonstrations, which show unrealistically high levels of savings. Hence, managers may focus their efforts on trying to identify and estimate maximum benefits and savings, at the expense of overlooking the 'full' cost implications of IT.

Traditional investment appraisal techniques, such as *Return on Investment*, *Internal Rate of Return*, *Net Present Value*, and *Payback* approaches are often used to appraise capital investments in IT (Ballantine and Stray, 1999). These techniques are based on conventional accountancy frameworks. They are specifically designed to assess the 'bottom-line' financial impact of investments, by often setting direct IT-related costs against quantifiable benefits achievable. However, as more organisations realise that such techniques are unable to accommodate strategic benefits and 'indirect' costs, many firms are left with the quandary of deciding which approach to use. Consequently, there has been ubiquitous debate about the types of techniques that constitute meaningful justification (Ballantine and Stray, 1999).

The inability of construction firms to quantify the 'full' implications of their investments in IT; from both a cost and benefit perspective questions the predictive value of those justification processes that are dependent on traditional appraisal techniques (Li *et al*., 2000). There remain, however, serious implications with not carrying out a rigorous evaluation process. Small and Chen (1995) point out a lack of management guidelines that support investment decision making may force organisations to adopt one of the following positions:

- refuse to implement an IT infrastructure that could be beneficial to the long-term competitiveness of the organisation;
- invest in IT as an 'act of faith'; or
- use creative accounting (assigning arbitrary values to benefits and costs) as a means of passing the budgetary process.

2.1 Cost Implications of IT

The costs of IT are often perceived to be easier to estimate than the benefits, though Hogbin and Thomas (1994) argue that this is rarely the case. The costs associated with IT implementation appear more tangible in nature because the assumptions and dependencies on which they are based are often not fully acknowledged, or are poorly understood by management. Indeed, it is considered widespread practice during the investment decision making process to account for the upper estimates for costs and the lower estimates for benefits (Hogbin and Thomas, 1994). However, this heuristic appears not to be solving the problem of IT projects running over budget, as much of the problem lies in management not 'fully' understanding IT cost portfolios. There might also be political and organisational reasons for not understating the cost implications of an IT investment; the main one being the need to gain support for, and acceptance from senior managers.

Farbey *et al*. (1993) found that those responsible for implementing IT in organisations are totally committed towards the 'success' of the IT investment often ignore the 'full' cost implications of their investment and thus advocate optimistic estimates of benefits and cost savings. In this instance, the failure to identify the 'full' cost implications, when combined with the use of over optimistic savings and benefits, may result in several extra years of use to achieve expected financial returns. The impact to the organisation being a reduction in productivity and competitiveness due to the prolonged use of outdated technology.

2.2 Direct Costs

'Direct' costs are those that can be attributed to the implementation and operation of IT, which are typically the focus of senior managers. Although, these costs often go beyond the initial user specification of the system. Direct costs may also include unexpected additional hardware accessories, such as increases in processing power, memory and storage devices. Installation and configuration costs are also classified as direct costs, and typically include consultancy support, installation engineers and networking hardware/ software. As hardware costs continue to fall in price, Wheatley

(1997) predicts that IT-related human and organisational costs are set to rise. Strassmann (1992) concluded that at the US Department of Defence, for every $1 spent on IT and associated equipment, a further $7 needed to be spent on 'softer' human and organisational issues. Hochstrasser (1992) suggests that human and organisational costs are rarely budgeted for in IT investment proposals, which may partially explain the phenomenon of 'cost-creep', which occurs when organisations implement IT infrastructures.

2.3 Indirect Costs

'Indirect' costs are typically comprised of human and organisational factors. One of the largest 'indirect' human cost being that of management time (Irani *et al.,* 1999). In other words, that time specifically spent on integrating new systems into current work practices. In the case of newly adopted technologies, management may spend time revising, approving and subsequently amending their IT related strategies. A significant amount of resource will also be used to investigate the potential of the IT, and in experimenting with new information flows and modified reporting structures (Love *et al*., 1996). Wheatley (1997) suggests that a further 'indirect' human cost, which is often overlooked, is that of system support and trouble shooting. System support cost factors are often substantial, with Wheatley (1997) reporting the results of a survey that found a third of respondent organisations could not estimate the additional cost of supporting IT in relation to its original purchase price. According to Wheatley (1997), typical lifetime support costs are at least 400% of the original purchase price. Further 'indirect' costs may result from employees developing new skills, and therefore increasing their flexibility/overall contribution towards the organisation. These employees may then request revised pay scales. Clearly, such 'indirect' costs associated with employee pay and rewards, together with the cost implications of increases in staff turnover need capturing, and bringing into the IT decision making arena.

The organisational costs of IT generally occur during the transformation from old to new work practices. According to Irani *et al*. (1997) a temporary 'loss' in productivity may be experienced, as employees go through a learning curve, while adapting to new systems, procedures and guidelines. Additional organisational costs may also be experienced once the basic functions of the system are in place. These costs are associated with management's attempts to capitalise on the wider potential of the system. Further costs include management's attempt to integrate information flows and increase its availability. The adoption of IT is likely to also result in the re-design of organisational functions, processes and reporting structures (Love and Gunasekaran, 1997). As pointed out by Li (1996), construction firms with extensive IT infrastructures in place, tend to change their corporate shape, by reducing the number of management levels. This is often achieved by re-defining the role of many management functions, through increasing their flexibility and overall contribution to the organisation (Love *et al*., 1998). The costs of organisational restructuring following the adoption of IT are considered to be expensive, particularly if isolated groups within the company resist change, and are unwilling to make the transition. These costs therefore need acknowledging and building into a suitable framework for the consideration by decision-makers.

3. RESEARCH METHODOLOGY

Previous research suggests that a construction firm's 'failure' with IT is primarily attributable to not meeting user expectations, which underlines the significance of the 'soft' human and organisational issues involved in IT (eg, Love and Gunasekaran, 1997). Bearing this in mind, the authors adopted a research methodology that would involve and enfranchise an organisation and their senior staff so that theory and knowledge about the decision-making process for IT could be derived to develop an

effective model for IT evaluation. The research presented in this paper focuses on the indirect costs and benefits of IT as this is considered to be an area that has received little attention in the normative construction management literature. The current research that is being undertaken involves a series of interventionist case studies undertaken by means of a structured-case research method (Checkland, 1995; Silverman, 1998).

3.1 Structured Case Method

The structured-case seeks to build theory, which may be seen as "*a system of interconnected ideas that condense and organise knowledge*" (Neuman 1991:p30) that attempts to explain, predict and/or provide understanding. The aim of adopting such an approach is to discover and discuss relationships between concepts, so as to build a 'web of meaning' with respect to the human and organisational issues of IT evaluation. The development of a series of conceptual frameworks (CF) as noted in Figure 1, from CF_1, CF_2… to CF_n is used to demonstrate the *process* of knowledge and theory building where CF_n is the latest version of the theory built to date. The theory-building process is not only inductive but is interrelated with practice. Applied research can lead to theory building, which can lead to further field research and more theory building. Thus the research cycle can lead to changes to the CF. Each new CF expresses the pre-understanding for the next cycle, as part of the hermeneutic circle (Gummesson, 1991). That is, the natural human act and process of interpretation and understanding of the world. Essentially, what is enacted is a spiral towards understanding, as current knowledge and theory lay the foundations for yet another research cycle that will expand, revise or validate the authors' understanding of IT evaluation in construction. This is particularly appropriate for IT, as it is an area distinguished by rapid changes in practice, which suggest the need for theory, and practice to become closely intertwined (Galliers, 1997). It is envisaged that the structured-case will enable theory to be developed that will reflect the concerns, problems and issues facing construction firms.

3.2 Initial Conceptual Framework

The initial CF_1, which is depicted in Figure 1, has been derived from the literature, practitioners insights, and the authors experiences, which the authors consider to be important in the IT evaluation process. As there has been limited IT evaluation research undertaken in construction the authors have used the normative literature to develop a CF for IT evaluation in construction at an enterprise level. As mentioned above, the authors' particular interests centre on the importance of human and organisational issues associated with the IT evaluation process, as the it is considered that the implementation of IT can have cascading effects throughout an entire organisation if these issues are not adequately addressed.

3.3 Justification of CF_1

The case for looking at a stakeholder perspective during the evaluation process itself has been well justified through the literature (e.g., Wilcocks and Lester, 1991). The importance of establishing taxonomies that take into consideration human and organisational aspects is a significant departure from the conventional approaches used to evaluate technological systems. By taking a stakeholder perspective it is suggested that the process of investment and implementation of IT should be driven by the organisations capability, the level of competency available and the inherent culture, values and level of experience available within the construction firm. It is therefore of vital importance that the following steps are closely adhered to in preparation of introducing change based on the implementation of IT:

- corporate commitment by selling the need for change and the importance of such an investment;

- communicating clearly the value, benefits and implications for such investments on people and the organisation itself;
- leading the change proactively by ensuring that the culture *per se* is not averse to modernisation and investment IT;
- the level of employee involvement and participation, empowerment of employees at various levels within the organisation; and
- a skill audit will have to take place prior to major investments such as in the context of IT and a necessary strategy of skill upgrade and development.

A stakeholder perspective during IT investment programs cannot and should not be considered as a one off, project-based approach. It is evidently clear that as construction firms enter an era based on IT, a continuous process of technological appraisal, evaluation, upgrading and integration needs to be adopted. This therefore makes a stakeholder orientation a continuous process.

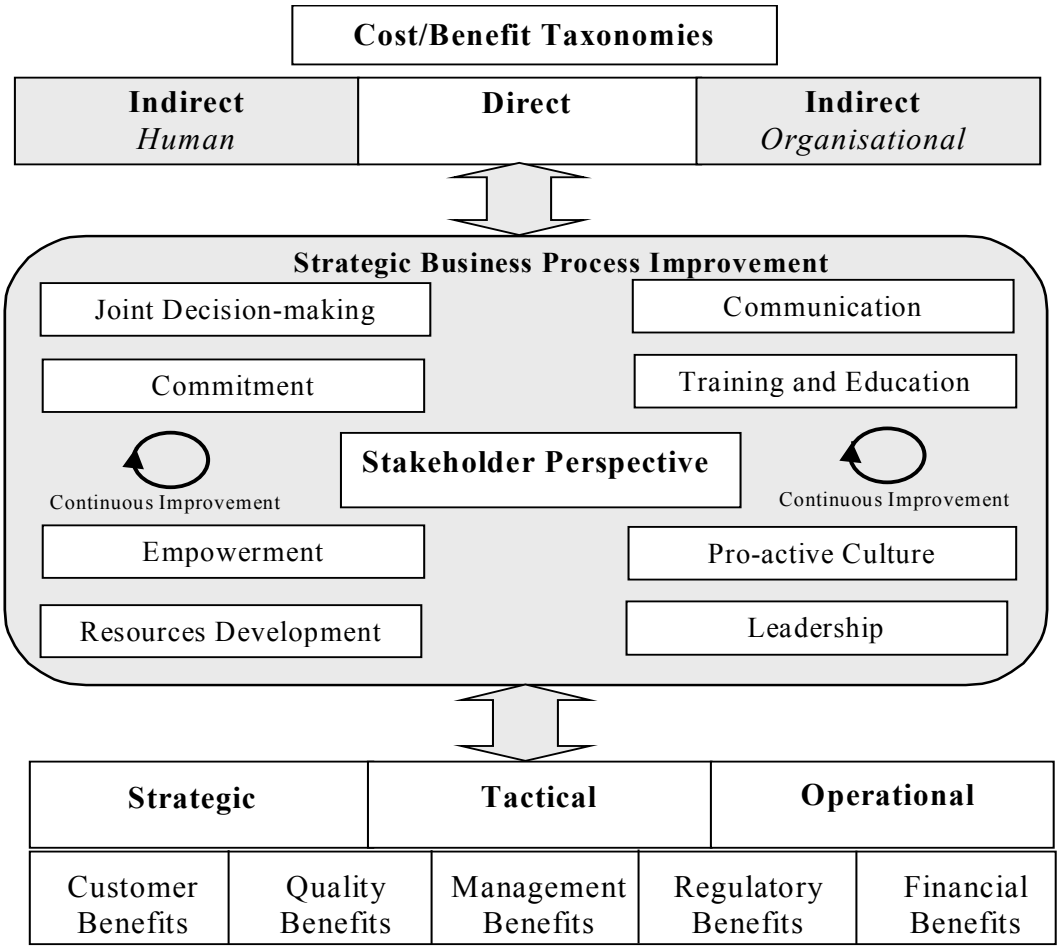

Figure 1. The Conceptual Framework (CF_1) for Construction IT Evaluation

Associated with this point is the fact that optimisation of the benefits will come from optimisation of the stakeholder perspective. Collective experience, expertise, experimentation, continuous improvement initiatives will gradually impact on the benefits that can be derived. The cost taxonomies proposed in CF_1 are the scope of consideration in this research. When considering IT investment it is no longer appropriate to include only conventional, economically based costs as the justification process needs to focus on variety of benefits at the strategic, tactical and operational level, as noted in Figure 1.

4. THE FIRST RESEARCH CYCLE

The first research cycle aimed to validate or further revise the proposed CF_1. The construction firm (ABC) used for the first research cycle was a large construction and engineering contractor that has constructed many of Australia's best known building's and landmarks. In 1998 the annual turnover for ABC was $430.5 million, and in 1999 it was $474.7 million. ABC has a solid client base, and it estimates that 80 percent of its current projects are for repeat clients. ABC has offices throughout Australia and overseas in Hong Kong, Indonesia and Papua New Guinea.

ABC has an extensive IT infrastructure in place. At a project level ABC only uses basic technologies as devices for inter-organisational communication. While ABC acknowledges the importance of IT as a mechanism for improving inter-organisational communication, the financial rewards that may be obtained from using IT are not considered to be beneficial in the short-term. At an enterprise level a packaged software system supports ABC's information management system (IMS). The package software system is used to store information on a central server for estimating, cost planning, contract administration, and document control purposes. ABC has upgraded and introduced new hardware and software during the last two years for example, document imaging systems, videoconference systems, e-mail and Internet and Intranet systems. The direct financial cost of implementing these technologies was estimated to be $650, 000 for the state office involved in this study, which had an estimated turnover of $55 million in 1998. ABC's management team did not undertake a rigorous IT evaluation process and as a result has encountered several difficulties, especially with the software system used to support strategic business processes.

4.2 Data Collection

The data collection procedure has followed the major prescriptions by most textbooks in doing fieldwork research (e.g., Yin, 1989). A variety of secondary data sources were used to collect data with regard to the development of IT taxonomies for evaluating IT investments, such as internal reports, budget reports, and filed accounts. A variety of data sources have been used to derive the findings presented in this paper, which include interviews, observations, illustrative materials (e.g., newsletters and other publications that form part of the case study organisation's history), and past project documentation. The authors have extensive industrial experience in the construction industry and have used this experience, together with a predefined interview protocol to determine the data needed for the research.

Interviews were conducted with the Regional Manager, Company Accountant, Quality Manager, Estimating Manager, Construction Managers, Project Managers, and general support staff at the enterprise-level. The duration of each interview was approximately thirty minutes, where every interview was conducted on a one-to-one basis, so as to stimulate conversation and breakdown any barriers that may have existed between the interviewer and interviewee. The authors acted as a neutral medium through which questions and answers were transmitted and therefore endeavoured to eliminate bias. In considering this, bias in interviews occurs when the interviewer tries to adjust the wording of the question to fit the respondent or records only selected portions of the respondent's answers. Most often however, interviewer bias results from the use of probes, where these are follow-up questions and are typically used by interviewers to get respondents to elaborate on ambiguous or incomplete answers (Shaughnessy and Zechmeister, 1994). In trying to clarify the respondent's answers the interviewer was careful not to introduce any ideas that may form part of the respondent's subsequent answer. Furthermore, the interviewer was also mindful of the feedback respondents gained from their verbal and non-verbal responses. As a result, the interviewer avoided giving overt signals such as smiling and nodding approvingly when a respondent failed to answer a question.

4.3 Case Study Validity

The use of interviews, documentary sources, and observations indicates that internal validity needed to be addressed. Interviews, in particular, were used to identify failure and success factors related to IT implementation, which had been discovered through examining the interviews. Each interview was taped recorded and subsequently transcribed. These were given to each person that had been interviewed to check and resolve *any* discrepancies that may have arisen and eliminate any interviewer bias. Bearing in mind the array of evidence that was accumulated, great care was undertaken by the authors to ensure that the data collected converged on similar facts as described by Jick (1979).

5. FINDINGS AND DISCUSSIONS

ABC considers itself to be a pro-active and innovative construction and engineering organisation. They have a corporate philosophy founded on quality and as result operates a continuous improvement philosophy. The implementation of quality assurance and subsequently CI was a long and arduous task, but ABC are now reaping the benefits eg, reduced rework, repeat client's, increased market share and increased profitability.

5.1 Decision-making

While reaping the benefits of their quality program ABC senior management (regional manager, company accountant, and construction manager) considered it was time to embrace the new millennium with a revised business strategy that centred on the strategic use IT. Senior management was convinced that IT would improve their organisation's business performance. Attendance at business seminars on the strategic use of IT, as well as the encouragement of State Governments to adopt IT were factors that influenced managements decision to invest and develop and an extensive IT infrastructure. Senior management considered that they were taking a long-term view when they decided to invest in IT. The regional manager stated that "*..investing in IT will improve communication within the organisation, especially our sites. We consider this to be a long-term invest and are committed to being an innovative organisation*". This statement contradicts the claims made by Lefley (1994) that managers are more susceptible to make short-term decisions with respect to new technology than any other aspect of their company. Lefley (ibid) further states that management is often reluctant to make long-term investments, as they are more amenable to their shareholders by investing in low risk short-term projects, which show high profits. This did not appear to be the case in ABC, as the investment in IT was considered to be a strategic decision, which would enable long-term benefits to be achieved. The company accountant stated that the decision to extend and implement IT was considered "*..a must, if the firm is to remain competitive in the future*". A budget was prepared by the company accountant and then different IT requirements were ranked in order of preference and in terms of the greatest perceived benefit by department heads (quality manager, estimating manager etc). After each requirement was ranked a cost was then allocated.

5.2 Employee Involvement

At no point did those people ranking the various technologies consider the indirect costs of implementation. Moreover, it was revealed that end-users had not been invited to participate in the decision-making process. The authors' found this surprising as ABC had always involved their employees in the organisation's decision-making process. In fact, employee involvement was seen to have been the key to ABC's success. So why were they not included in deciding the IT requirements of the firm? It was difficult to obtain an answer to this question and is something that

the authors' found puzzling to say the least. From the interviews undertaken with employees and management it was simply a case of "management knew best" in this instance. It was also observed from the interviews that certain managers had hidden agenda's to push, as they sought particular technologies to improve the effectiveness of business processes they were involved with. Promotions and bonuses within ABC were related to performance so if departments were performing well the respective departmental manager would be given due credit.

5.3 Leadership

There was a lack of leadership during the decision-making and implementation process. There was a degree of confusion within the organisation as to who was responsible for leading the IT project. Essentially, departmental managers were responsible for implementing IT within their specific areas. This created a degree of confusion as the company accountant and quality manager, who were responsible for implementing the packaged computer system, did not coordinate the loading of software to individual machines with departmental managers. This resulted in a delay to the systems operation, which subsequently had a negative influence employee morale. Software glitches were also encountered, which in turn had an impact on the productivity of employees. In hindsight ABC should have developed bespoke software so it matched the requirements and needs of end-users. However, it was considered cheaper (reduced development costs) to purchase packaged software and amend it to suit the requirements of the firm. However, this has been a cumbersome and time-consuming task. The costs associated with amending the software are on going. ABC acknowledges the problems associated with purchasing packaged software and are now considering bespoke software.

5.4 Communication

The reasons why ABC introduced new technologies were deemed to be obvious by management but not so to employees. Meetings were held to discuss the implementation process after the decision to invest had been made. There was little communication between management and employees, especially those on site. One project manager made the following comment "*..I do realise that IT can improve the way we do things, but what am I going to do. I've never used a computer in my life. There's no way I can start using one now...I'm almost 50*". What management had failed to do in this instance was inform staff that they would provide training and support for those using the new IMS.

5.5 Resources Development

Time was a factor that was overlooked during the implementation process. It was assumed that employees would conduct their day-to-day activities as well as become involved with the installation of new systems and technologies. Many employees found themselves working overtime during the implementation phase. Expertise was brought in from outside to assist with the installation of software and hardware systems. However, this was not considered enough, as users had specific software and hardware requirements that had not been taken into accountant. While it was acknowledged during the initial decision-making process that an IT manager and a technician were needed they were not employed until six months after the initial implementation phase. This was because it was difficult to recruit experienced IT personnel, as there was a shortage of IT personnel with construction industry experience.

Training costs were not considered during the evaluation phase, they were simply overlooked. The costs of training were found to be considerable, as almost all people within the organisation had to be sent on an IT training course. Employees using the new technologies and software programs stated that their productivity had decreased

and that they had to work longer hours. Moreover, it was revealed that while employees were away from their jobs due to re-training their colleagues work patterns were also disturbed. During this unfamiliarity phase, the losses in productivity did not go unnoticed by senior management. The regional manager stated "*..we made a mistake thinking that employees would automatically take to the new technology. Morale was poor at one stage because we failed to communicate our intentions. We are now doing our best to provide assistance and support those employees that need it. You'll always get teething problems when you introduce something new into an organisation, but sometimes you have to take a risk and deal with the consequences as they arise. In hindsight we should have done things differently*". These consequences could have been accounted for during the evaluation stage, which in turn would have reduced the firm's overhead and operating costs. Noteworthy, it is estimated that the total cost (which is on going) for implementing IT may well be in excess of $2 million, which is three times that originally budgeted for by ABC.

5.6 Human and Organisational Costs

The implementation of the packaged software IMS and Intra-net system meant that information was more readily available, which improved decision-making and communication. The introduction of the new systems meant that single departments were no longer needed. ABC's organisational structure was re-designed to enable teams to be formed for particular projects. The new systems required employees to become multi-skilled, as information was readily available. The organisational boundaries that had previously existed within ABC essentially acted as obstacles to information flow and decision-making. Business process needed to be re-designed, as there was no further need for functional departments. The change in organisational structure meant that multi-skilled teams were formed to perform activities for specific projects. The internal layout of ABC's head office has become more open and overtime it is anticipated that this will influence the culture of the firm. The re-design of the ABC's organisational structure resulted in management spending time on integrating new systems into current work practice; a cost that had not been allowed for during the evaluation phase.

Two estimators that were close to retirement found the notion of using IT to perform their work too daunting, and as a result took earlier retirement. If staff had been involved in the decision-making process then these employees would have been able to prepare themselves for the change that had been cast upon them. In this instance it is very difficult to demonstrate that IT caused these employees to retire. However, the changes imposed on the organisation would have probably favoured newer, younger employees who were able to learn more quickly. Thus, the older employees may have lost their credibility because their knowledge and experience would have been tied to the previous work methods. The dis-benefits often associated with IT are largely caused by the way individuals react to change and not IT itself. Too some extent this was the case at ABC, as employees were not confident in the decisions made by senior management because they had not communicated the reasons why change, in the form of IT, was being introduced. But, however good a firm is, at least some employees will always suspect the motives of management, simply because that is how people behave when confronted with change.

6. CONCLUSION

Construction firms need to undertake a rigorous evaluation process before implementing IT if they are to achieve improvements in their business performance, otherwise inefficiencies in decision-making and resource deployment will prevail. In addition, management needs to go beyond the use of traditional modes of investment justification, (which are based on the use of economic appraisal techniques) and introduce the indirect costs into the formal decision-making process. This not only

questions the value of traditional justification processes but also has implications regarding the actual successes of many IT deployments. The case study identified problems that arose from not undertaking a rigorous investment evaluation process. Problems associated with the deployment IT such as training, lack of end-user involvement, process re-design have been addressed by case study firm, but at a cost! Despite the associated cost the construction firm has experienced many benefits such as quality of service improvements, cost savings (reduction in clerical salaries etc), and improved communication.

ACKNOWLEDGEMENTS

The authors would like to thank the contracting organisation for its participation in this study. Without its cooperation and support from management and employees the research could not of been undertaken. The authors also would like to acknowledge the financial support provided by the Australian Research Council and the Engineering and Physical Sciences Research Council (EPSRC) Ref: [GR/M95066].

REFERENCES

Alter S. (1999). *Information Systems: A Management Perspective*. Addison-Wesley, Third Edition, USA.

Andresen, J. (2000). *The Unidentified Value of IT in Construction Industry*. Proceedings of the International Conference on Information Technology in Construction: Implementing IT to Gain a Competitive Advantage in the 21st Century, Department of Building and Real Estate, Hong Kong Polytechnic University, January 17th –18th Hong Kong, pp.93-105.

Ballantine J and Stray S. (1999). Information Systems and Other Capital Investments: Evaluation Practice Compared. *Logistics and information Management*, **12**(1-2), pp.78-93.

Checkland, P. (1995). Soft Systems Methodology and Its Relevance to Information Systems. In F. Stowell (ed.) *Information Systems Provisions: The Contribution of Soft Systems*, McGraw-Hill, London, pp.1-17.

Cheung, E.W.L, Li, H, Love, P.E.D., and Irani. Z. (2000). A Conceptual Framework for a Total Information Networking System in Construction. *International Journal of Technology Management* (In Press)

Debras, P., Moneceyron, J-L., Bauer, F., and Ballesta, P. (1998). *An Information Server for the Building Industry: Interest of a STEP/IFC Based Approach*. Proceedings of Second European Conference on Product and Process Modelling in the Building Industry, Building Research Establishment Ltd, October 19th – 21st Watford, UK.

Farbey B, Land F and Targett D. (1993). *IT Investment: A Study of Methods and Practices.* Published with Management Today and Butterworth-Heinemann, UK.

Galliers, R.D. (1997). Reflection on Information Systems: Twelve Points to Debate. *Information Systems: An Emerging Discipline*. In J. Mingers and F. Stowell (eds.), McGraw-Hill, Berkshire, UK, pp.113-136.

Gummerson, E. (1998). *Qualitative Methods in Management Research*. Sage, Newbury Park, CA.

Hochstrasser B. (1992). *Justifying IT investments*. Conference Proceedings: AIS; The New Technologies in Today's Business Environment, pp. 17-28.

Hogbin G and Thomas D.V. (1994). *Investing in Information Technology: Managing the Decision-making Process*'. McGraw-Hill/IBM Series, Cambridge, UK.

Irani Z, Ezingeard J-N and Grieve R.J. (1997). Integrating the Costs of an IT/IS Infrastructure into the Investment Decision-making Process. *The International Journal of Technological Innovation, Entrepreneurship and Technology Management (Technovation)*, **17**(11/12), pp.695-706.

Irani, Z., Love, P.E.D., and Li, H. (1999). *IT/IS Investment Barriers to the Decision-Making Process*. Proceedings of the Business Information Technology: The Global Imperative Conference, The Department of Information Systems at the University of the Western Cape The BMW Pavilion, Victoria and Alfred Waterfront, Cape Town, 30th June – 2nd July, South Africa [CD-Proceedings]

Irani, Z., and Love, P.E.D. (2000). The Propagation of Technology Management Taxonomies for Evaluating Investments in Manufacturing Resource Planning (MRPII). *Journal of Management Information Systems* (In Press)

Irani, Z., Love, P.E.D., Sharif, A.M., and Li, H. (2000). The Failure and Success of a Manufacturing Information System: A Case Study. *European Journal of Information Systems* (In Press)

Irani, Z., Love, P.E.D. and Zairi, M. (2000). Assessing the Social Constructs of Information System Investment Evaluation: A Focus on MRPII at Helco Inc. *IEEE Transactions on Professional Communication* (In Press)

Jick, T.D. (1979). Mixing qualitative and quantitative methods: triangulation in accumulation. *Administrative Science Quarterly*, **24**, 602-611.

Lefley F. (1994). Capital Investment Appraisal of Manufacturing Technology. *International Journal of Production Research*. **32**(12), pp. 2751-2756.

Lefley F and Sarkis J. (1997). Short-termism and the Appraisal of AMT Capital Projects in the US and UK. *International Journal of Production Research,* **35**(2), pp.341-355.

Li, H. (1996). Towards Quantitatively Measuring the Performance of Construction IT Systems. *Building Research and Information*, **24**(1) pp. 379-382

Li, H., Love, P.E.D. and Irani, Z. (2000). The Relationship between the use of IT/IS and the Productivity of Consulting Firms in Construction. *International Journal of Construction Information Technology* (In Press).

Love, P.E.D., and MacSparron, C. (1996). The Use Information Technology by Australian Construction Contractors. *The Chartered Building Professional*. June, pp.14-18.

Love, P.E.D., MacSporran, C., and Tucker, S.N. (1996). *The Application of Information Technology by Australian Contractors: Toward Process Re-engineering*. Fourth International Conference on Lean Construction, 25th-27th August, University of Birmingham, UK.

Love, P.E.D., and Gunasekaran, A. (1997). Process Re-engineering: A Review of Enablers. *International Journal of Production Economics*. **50**(2/3), pp.183-197.

Love, P.E.D., Gunasekaran A., and Li, H. (1998). Putting an Engine into Re-engineering: Toward a Process Based Organisation. *International Journal of Operations and Production Management* **18**(9), pp.937-949.

Neuman, W.L. (1991). *Social Research Methods: Qualitative and Quantitative Approaches*. Allyn and Bacon, Boston.

Primrose P.L. (1991). *Investment in Manufacturing Technology.* Total Technology Department, UMIST, Manchester, Chapman and Hall, London, UK.

Rivard, H. (1999). *A Survey of Information Technology in the Canadian Construction Industry*. In M.A. Lacasse and D.J. Vanier (eds.) National Research Council of Canada, Vancouver, pp.2339-2347.

Shaughnessy, J.J., and Zechmeister, E.B. (1994). *Research Methods in Psychology*. 3rd Ed McGraw Hill.

Small M. H and Chen J. (1995). Investment justification of advanced manufacturing technology: An empirical analysis. *Journal of Engineering and Technology Management*, **12**(1-2), pp.27-55.

Silverman, D. (1998). Qualitative Research: Meanings or Practice? *Information Systems Journal* **8**(1), pp.3-20.

Strassmann P. (1992). The Politics of Downsizing. *Datamation*, 15th October, pp.106-110.

Wheatley M. (1997). Hidden Costs of the Humble PC. *Management Today*, January, pp. 52-54.

Yin, R.K. (1989). *Case Study Research – Design and Methods*. Applied Social Research Method Series, Vol.34, Sage Publications, Newbury Park.