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IDENTIFYING IT BENEFITS FOR MALAYSIAN CONSTRUCTION COMPANIES

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SUMMARY*: Construction companies are experiencing an increasing use of IT in different disciplines. Previous studies reported problems of insufficient bandwidth, lack of training, and the unavailability of expert users in construction companies in Malaysia. Furthermore, the existing infrastructure of IT is deficient and the number of trained workers is inadequate. Additionally, the full potential of the Internet has not been utilized by Malaysian construction companies; however, 50% of them make a decision to implement IT without a feasibility study. Consequently, there is a need for more focus on the benefits of IT in the construction industry. The objective of this study is to identify the benefits of IT that have been achieved by construction companies of Malaysia.*
To achieve study objectives, data was collected using a questionnaire survey. The study focused on 3,705 Grade Seven G7 construction companies. About 805 questionnaires were sent and about 103 of the questionnaires were completed and returned.
This study categorized IT benefits in 12 clusters then came up with three main benefits as a result of the questionnaire survey. The study findings showed that while construction company managers realized that IT usage improved management but did not see an increase in flexibility due to IT usage. Additionally, the construction companies did not see increased profits due to IT usage. However, the overall findings showed that construction companies were aware of the benefits of IT usage but were still in the preliminary stage of IT use.
Future studies may examine the realized IT benefits in other fields of construction industry and in other regions as well.

KEYWORDS: *Construction work, Construction companies, IT, IT benefits*

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1. INTRODUCTION

With regard to labor, the nature of construction companies is information-based: -- with the majority of jobs related to projects, which generate large amounts of data and information that is documented and exchanged among the parties of the construction team (Sommerville and Craig, 2006). In general, communication and documentation are fragmented, yielding reduced productivity because of the fragmented nature of construction work. Moreover, the launching of numerous or large overseas projects generates many problems. In other words, the major problems and concerns of construction companies are related to generating, documenting, updating and exchanging data and information. The construction companies usually use Information Technology (IT) in order to overcome problems and achieve improvements in construction process.

The use of IT in the construction industry can achieve operational as well as tactical and strategic benefits (Love et al 2004, Stewart 2008); therefore the realized benefits of IT could be tangible and direct or intangible and indirect, depending on the nature and scope of the benefits (Suwardy et al 2003, Love et al 2004). Moreover, the benefits of using IT in the construction industry should be apparent in such business success criteria as increased work efficiency, effectiveness and performance of the construction projects (Alshawi et al, 2003). However, implementing IT in construction companies does not always have economic justification and does not usually provide all the benefits initially envisaged at the expected time (Andresen et al 2000, Alshawi et al 2003).

Construction companies face management challenges in project scope, cost, schedule and complexity or inter-relativity of construction tasks; therefore, their main objectives are ensuring up-to-date work progress reports, managing work-related problems and fulfilling the optimum distribution of resource management (Svidt and Christiansson, 2006). These challenges force construction companies to invest in IT to handle documentation and data processing efficiently with minimum delays and errors, as well as to set connections between all the branches of construction work. IT has been an effective tool adopted in other industries to enhance work processes and achieve digital-based documentation and communication, resulting in a real-time connection among work stakeholders and suppliers (Fischer and Kunz, 2004). The use of IT reduces task fragmentation and improves coordination and collaboration, resulting in better communication practices among team members of the construction project (Stewart et al, 2002). The implementation and use of IT is not a straightforward process because many issues need to be considered in the earlier stages of IT projects. An IT project is a process of realizing an IT application or a facility through a process consisting of IT selection, planning, implementation and evaluation. The challenges of implementing and using IT in construction companies were clarified by Schwegler et al. (2001) and Peppard et al. (2007) as follows:

- Costing and cost control of IT projects (including the hardware and software).
- Keeping the data performance of the design and construction secure throughout the project life-span without hindering the flow of necessary information.
- Sharing data across multidisciplinary and multiphase contexts of construction projects.
- Ensuring the delivery of positive outcomes and explicit business benefits.
- Avoiding the negative outcomes of IT investment by preparing a comprehensive study before the decision making of IT investment.

In general, IT benefits constitute the difference between the desired improvements and the current situation. The IT benefits for construction companies necessitate management interference to be managed and realized. The strategic IT benefits for construction companies do not occur unless dramatic changes take place, because the technology only enables, and benefits don't come about automatically (Alshawi et al 2003, Norton 1995). A specific style of management may realize IT benefits in a short time frame. Other benefits require more time for maturity, therefore, there is a time gap between the initial investment and revenues (Peppard et al, 2007). Some benefits have direct and tangible effects on productivity, while others have intangible results in terms of effectiveness and performance (Andresen et al, 2000). The studies of Lederer and Mirani (1995), Lin and Pervan (2003) inferred that a full understanding and consideration of IT benefits for construction companies would achieve the following:

- Understanding all features of IT projects effectively.
- Maximizing management expectations of IT benefits.
- Giving some guidance to IT managers when they are taking on new projects and recommending priorities in their choice of IT project.

There are a number of barriers that may retard and prevent the realization of IT benefits in a construction company, as stated by Lin and Pervan (2003), such as the following:

- Not all expected IT benefits of an IT investment are short term results.
- The required changes to realize IT benefits cannot be identified accurately.
- Accuracy is difficult in the planning for realizing IT benefits.
- Bad IT investment documentation fails to identify, in advance, the real IT benefits.
- The abilities of change leadership in construction companies are limited.

This research study identified different categories and types of IT benefits that could be achieved throughout the lifecycle of IT projects. The study also examines IT benefits in actual practice to identify the achieved IT benefits for construction companies.

2. CATEGORIES AND TYPES OF IT BENEFITS FOR CONSTRUCTION COMPANIES

Previous studies (Andresen et al, 2000, Lin and Pervan, 2003, Suwardy 2003, Love et al, 2004, Stewart 2008) reported different and overlapping ways of classifying categories of IT benefits in construction companies, defining these according to the nature and type of benefit, as shown in Table 1. IT benefits in any organization or company are recognized in terms of efficiency, effectiveness and performance (Andresen et al, 2000).

TABLE 1: Categories of IT Benefits for Construction Companies.

Category of Benefit	Category Code	Category Definition
Tangible	A1	Some benefits are tangible and can be directly measured while others cannot be measured directly because they are intangible.
Intangible	A2	
Strategic	B1	Benefits at the strategic level are difficult to quantify because they are soft and uncertain. On the other hand, tactical and operational benefits focus on efficiency so can be more easily identified and quantified.
Tactical	B2	
Operational	B3	
Near-Term	C1	When implementing IT system, a number of benefits appear near-term and some can be implemented and in the medium-term, while others require a long-term implementation.
Medium-Term	C2	
Long-Term	C3	
Efficiency	D1	Benefits can be classified according to their impact on business success criteria which are efficiency, effectiveness and performance.
Effectiveness	D2	
Performance	D3	

Efficiency is the rate at which inputs are converted to outputs, effectiveness is the rate of actual outputs compared to the planned, and performance is the level of new outputs enabled (Lin and Pervan, 2003). Tangible benefits, called direct tangible benefits, can be measured directly, while others, called indirect intangible benefits, could not be measured (Suwardy 2003, Love et al 2004). Additionally, benefits can be classified, according to the scope, into strategic, tactical and operational categories. Benefits at the strategic level are harder to quantify because they are unquantifiable and uncertain. On the other hand, tactical and operational benefits typically relate to efficiency and so can be identified and quantified (Love et al 2004, Stewart 2008). During IT implementation and use, some IT benefits can be realized in a short time period while others need more time (Schwegler et al, 2001).

The previous studies, listed in Table 2, identified many types of IT benefits. The IT benefits could be categorized based on types into 12 IT benefits illustrated in Table 2 which serves to clarify both category and reference of each benefit in addition to the cluster. Briefly, the clusters of benefits are Client Satisfaction, Cost Reduction, Improving Management, Competitiveness Advantages, Improving Business Success Criteria (i.e. efficiency, effectiveness and performance), Increasing Response Rate, Increasing Work Flexibility, Increasing Market Share, Improving Information Quality, Improving Organizational Growth, Improving Work Relations, and Reducing Working Time.

TABLE 2: Summary of IT Benefits for Construction Companies with Regard to Categories Benefits Grouped by Cluster.

Cluster of Benefits	Description of Benefits	Benefit Categories	Reference
Client Satisfaction	Attaining client expectations.	A2, B1, C1 and D3	Suwardy et al, 2003
	Improving client satisfaction.	A2, B1, C3 and D3	Love et al, 2004
	Improving focus on client requirements.	A2, B2, C2 and D3	Andresen et al, 2000
	Improving service.	A2, B2, C3 and D3	Love et al, 2004
Cost Reduction	Reducing marketing costs.	A1, B3, C2 and D1	Love et al, 2004 and Andresen et al, 2000
	Reducing work transaction costs.	A1, B3, C2 and D1	Andresen et al, 2000, Eadie et al, 2010
	Reducing operating costs.	A1, B3, C2 and D1	Andresen et al, 2000, Eadie et al, 2010
	Reducing labour costs.	A1, B3, C1 and D1	Love et al, 2004
	Reducing staff requirements.	A1, B3, C1 and D1	Andresen et al, 2000
	Reducing training costs.	A1, B3, C2 and D1	Andresen et al, 2000
	Increasing ability to provide instant price quotations of procurements to clients.	A1, B1, C1 and D2	Andresen et al, 2000
	Improving finance transaction methods.	A2, B1, C2 and D3	Andresen et al, 2000
	Achieving greater integration with other work functions.	A2, B1, C2 and D3	Love et al, 2004
	Increasing profit margins.	A1, B3, C2 and D1	Eadie et al, 2010
	Strategic cost savings.	A2, B1, C3 and D2	Eadie et al, 2010
Improving Management	Providing better information to management.	A1, B3, C1 and D2	Suwardy et al, 2003
	Improving data management data.	A1, B3, C2 and D2	Love et al, 2004
	Improving full life-cycle information management.	A1, B1, C3 and D2	Andresen et al, 2000
	Improving contract administration.	A1, B2, C2 and D2	Love et al, 2004
	Improving quality of decision-making in design and construction.	A1, B3, C1 and D2	Love et al, 2004
	Reducing project risk efficiently.	A2, B1, C3 and D3	Schwegler et al, 2001
	Minimizing business risk.	A1, B2, C2 and D2	Andresen et al, 2000
	Reducing technology risks in design and construction.	A1, B2, C2 and D2	Andresen et al, 2000
	Enhanced inventory management.	A2, B2, C2 and D2	Eadie et al, 2010
Competitiveness Advantages	Increasing the strategic competitive advantage.	A2, B1, C2 and D3	Suwardy et al, 2003, Andresen et al, 2000, Love et al, 2004 and Eadie et al, 2010
	Keeping up with competitors.	A2, B1, C3 and D3	Suwardy et al, 2003
Improving Business Success Criteria	Increasing work operations efficiency.	A1, B3, C2 and D1	Suwardy et al, 2003
	Reducing number of redundant tasks.	A1, B3, C2 and D1	Schwegler et al, 2001
	Exchanging ideas and viewpoints among project team members.	A2, B1, C2 and D3	Andresen et al, 2000
	Improving process of developing project information.	A2, B1, C2 and D3	Schwegler et al, 2001
	Increasing ability to handle complex projects.	A2, B1, C3 and D3	Schwegler et al, 2001
	Increasing project value.	A1, B2, C3 and D1	Schwegler et al, 2001
	Improving work productivity.	A1, B3, C3 and D1	Andresen et al, 2000
	Improving quality of output in management, design and construction.	A1, B1, C3 and D2	Andresen et al, 2000
	Achieving substantial reduction or elimination of rework.	A1, B3, C3 and D1	Love et al, 2004
	Improving planning process by simplifying updating process.	A1, B3, C2 and D1	Love et al, 2004
Increasing Response Rate	Improving ability to respond to changing conditions.	A1, B2, C1 and D2	Schwegler et al, 2001
	Faster response to client enquiries.	A1, B3, C1 and D1	Andresen et al, 2000
	Faster response to project requirements and problems.	A1, B3, C1 and D1	Andresen et al, 2000
	Increasing responsiveness of senior management to business problems.	A2, B1, C2 and D3	Suwardy et al, 2003and Andresen et al, 2000
	Faster response to supplier quotations.	A1, B2, C1 and D2	Andresen et al, 2000
	Faster response in arranging urgent meetings for construction project.	A1, B2, C2 and D2	Andresen et al, 2000
Cluster of Benefits	Description of Benefits	Benefit Categories	Reference
Increasing Work Flexibility	Increasing work flexibility.	A1, B1, C2 and D3	Suwardy et al, 2003
	Improving organizational and process flexibility.	A1, B1, C2 and D3	Love et al, 2004
	Improving integration between different business functions.	A1, B2, C2 and D2	Love et al, 2004
Increasing Market Share	Increasing market share.	A2, B1, C2 and D3	Suwardy et al, 2003
	Achieving strategic intelligence of new markets.	A2, B1, C2 and D3	Andresen et al, 2000
	Realizing market leadership.	A2, B1, C2 and D3	Love et al, 2004
Improving Information Quality	Increasing quality of information.	A1, B3, C2 and D2	Suwardy et al, 2003
	Reducing paperwork.	A1, B3, C1 and D1	Love et al, 2004 and Andresen et al, 2000
	Improving information availability.	A1, B3, C1 and D2	Schwegler et al, 2001
	Increasing ability of exchanging data and information.	A1, B3, C2 and D1	Love et al, 2004

	Facilitating the process of getting meaningful information.	A2, B1, C1 and D3	Andresen et al, 2000
	Increasing ability to handle enquiries.	A1, B3, C1 and D1	Andresen et al, 2000
	Reducing storage requirements.	A1, B3, C2 and D1	Andresen et al, 2000
	Improving delivery scheduling of procurement.	A1, B3, C2 and D1	Andresen et al, 2000
	Reducing lost of project information.	A1, B3, C2 and D1	Andresen et al, 2000
	Improving recording process of staff skills.	A1, B2, C2 and D2	Andresen et al, 2000
	Improving external access to records of procurement.	A2, B1, C2 and D3	Andresen et al, 2000
	Improving communication between management stakeholders.	A1, B3, C1 and D2	Love et al, 2004
	Enabling data collaboration between parties in entire work without re-entry.	A2, B1, C3 and D3	Schwegler et al, 2001
	Improving integration in design process.	A1, B2, C2 and D2	Andresen et al, 2000
	Improving ability of referring back to data.	A1, B2, C2 and D2	Andresen et al, 2000
	Reducing impact of mistakes.	A1, B2, C1 and D2	Schwegler et al, 2001
	Getting more relevant and reliable data.	A2, B1, C2 and D3	Andresen et al, 2000
Improving	Improving growth and success.	A2, B1, C3 and D3	Love et al, 2004
Organizational	Providing space and capacity for business growth.	A2, B1, C3 and D3	Andresen et al, 2000
Growth	Satisfying requirements for new technology.	A2, B1, C2 and D3	Love et al, 2004
	Promoting proactive culture.	A2, B2, C3 and D3	Love et al, 2004
Improving	Improving teamwork.	A2, B2, C2 and D3	Love et al, 2004
Work Relation	Improving ability to develop technical skills and select appropriate staff.	A1, B3, C2 and D2	Andresen et al, 2000 and Eadie et al, 2010
	Improving employee relations within office.	A2, B1, C2 and D3	Andresen et al, 2000
Reducing	Reducing time required to collect construction tenders.	A1, B2, C2 and D1	Love et al, 2004
Working Time	Reduced time of preparing cost plans.	A1, B2, C2 and D1	Love et al, 2004
	Reducing overall procurement cycle time.	A1, B2, C2 and D1	Andresen et al, 2000 and Eadie et al, 2010
	Reducing invoicing time.	A1, B3, C2 and D1	Andresen et al, 2000
	Reducing lead times for design.	A1, B3, C2 and D1	Andresen et al, 2000
	Reducing project-planning time.	A1, B3, C2 and D1	Andresen et al, 2000
	Reducing project duration time.	A1, B3, C2 and D1	Andresen et al, 2000
	Increasing service delivery.	A1, B2, C2 and D2	Andresen et al, 2000
	Reducing communication time.	A1, B2, C1 and D2	Eadie et al, 2010
	Reducing time through greater transparency (fewer objections).	A1, B2, C2 and D2	Eadie et al, 2010
	Reducing work evaluation time.	A1, B2, C1 and D2	Eadie et al, 2010

3. RESEARCH FRAMEWORK

The framework is as follows: An IT benefit is defined as the aim of an IT project in one of the four phases constitutes the lifecycle process of an IT project. These phases are IT Project Selection, IT Project Planning, IT Implementation and IT Evaluation (Ward et al, 1996, Steward et al, 2002, Lin and Pervan, 2003), as shown in Figure 1. The selection of an IT project is based on a study of requisite IT benefits, while the planning represents the most important part in any project because all necessary changes and responsibilities, as well as expected results are determined in this phase. During the selection and planning processes, it is very important to review the benefits realized by previous IT projects, using previous projects as a benchmark for the current project. The crucial process of an IT project is the Implementation and Monitoring phase, which consists of technical, as well as the managerial factors to provide the requirements of successful implementation (Peansupap, 2004). It is necessary to monitor IT implementation to ensure that everything progresses correctly and smoothly, and allows the exchange of viewpoints and impressions about implementation.

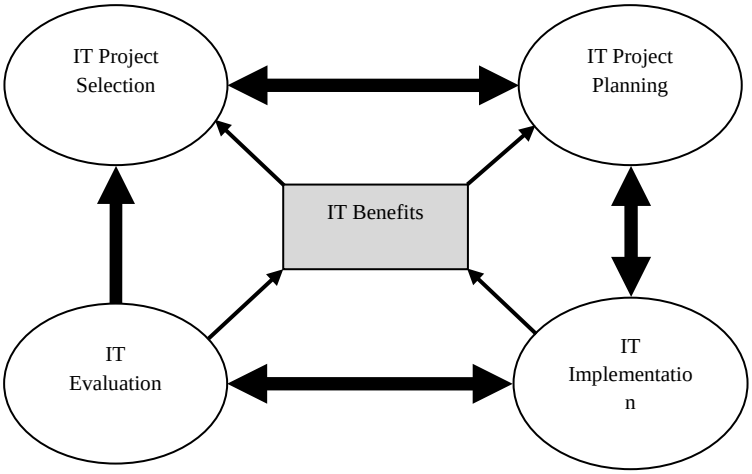

FIG. 1: Conceptual Framework for Realizing IT Benefits within the Lifecycle of an IT Project.

Some IT benefits can be realized during the IT Implementation phase while long term benefits require more time. The IT Evaluation phase consists of calculations required to determine and realize IT benefits as well as to provide feedback to management in considering the future decision making of an IT project.

4. PROBLEM STATEMENT

Some realized benefits from an IT project are less than expected while other unforeseen benefits materialize (Remenyi et al, 1997, Lin and Pervan, 2003, Alshawi et al, 2003). The Malaysian construction industry is experiencing an increasing use of IT in different disciplines. In line with the National IT Agenda, which was formulated in 1996, the Malaysian government has been aggressively promoting IT and its application in every sector, including the construction industry (Yoke et al, 2002). The Construction Industry Development Board (CIDB 2008), which was set up to standardize and modernize the construction industry, has also made an effort to promote IT in line with the government policy. Yoke et al. (2002) found that the Internet is important in 50% of construction companies. Further, Yusuf and Osman (2008) found that there were three levels of IT usage in Malaysia, namely, computerizing work, advanced application and online technologies. The results of their survey in Malaysian construction companies showed that 91% have computerized their work, 78.6% have adopted advanced IT applications and 77% have subscribed to broadband facilities. On the other hand, Yusuf and Osman (2008) reported that the local Malaysian construction industry was facing insufficient bandwidth, lack of training and unavailability of expert users. The issues regarding IT adoption were earlier highlighted by Yoke et al. (2002) who found that the full potential of the Internet was not utilized by Malaysian construction companies. Moreover, they found that around half of the construction companies decided to adopt IT regardless of problems and needs; instead these companies followed the other successful companies. Further, Yoke et al. (2002) suggested that there was a need to improve the existing infrastructure of IT and to construct more trained workers.

Ramayah et al. (2003) and Jaafar et al. (2007a, 2007b) found that managers in Malaysian construction companies experienced considerable discomfort and insecurity towards the use of IT. Hussan et al. (2008) goes further to conclude that, in Malaysia, there is no explicit understanding of how to use IT to improve company performance. While many companies are aware and familiar with IT, few have fully embraced it; while many others are still in early adopters (Rogers, 1995).

Consequently, the extensive use of IT and the related issues (such as lack of understanding and realizing IT benefits) encourage the management to place more attention on identifying IT benefits; however, the previous studies of IT investment have detected a lack of management attention to the unrealized benefits of IT projects.

5. RESEARCH OBJECTIVE

To identify the realized IT benefits for Malaysian construction companies. To find the answer for the question: Do construction companies in Malaysia realize IT benefits?

6. RESEARCH METHODOLOGY

This research adopted a quantitative research method which constitutes a questionnaire survey of a Likert Scale (1 = strongly disagree to 5 = strongly agree). The preliminary literature review served to detect research problems. The methodology consisted of a comprehensive literature review related to IT benefits. In this study, the questionnaire constructs were tested through a pilot survey and the reliability analysis presented a Cronbach's Alpha score of 0.88 which above 0.7 the minimum accepted value for a reliability test (Pallant, 2001).

The research scope of this study is the Grade Seven (G7) construction companies because these companies have the greatest need for IT and have already adopted IT (Yusuf and Osman, 2008). A G7 is defined as a company of at least two persons that have five years construction's experience. One employee is a degree holder in a construction-related field and the other is a diploma holder in a construction-related field or some other field. The G7 company had to have paid-up capital of not less than RM 750,000 and have unlimited tendering capacity, with capacity of more than RM 10 million (CIDB, 2008).

The research population of this study is 3,750 companies, which constitute the total number of active and new G7 construction companies (CIDB, 2008). The method of sampling we used was the Stratified Random Sampling to ensure that the study covered all of Malaysia (Sekaran, 2003). About 805 questionnaires were sent during a six-month period (April to October 2009). The total number of returned questionnaires was 125. Within the collected questionnaires, 23 forms were uncompleted and were disregarded, while 103 forms were completed. These 103 surveys consisted of usable data as all questions were answered properly and completely.

Final findings of this study will be helpful in identifying IT benefits in the construction companies. This research will present conclusions and recommendations based upon the findings of the quantitative study, the qualitative study, and the process model.

This research adopted three methods of data analyses using SPSS software (version 16.0), namely, Descriptive Statistic (DS), Factor Analysis (FA) and a One Way Analysis Of Variance (ANOVA). The DS included the mean values for results obtained by Likert scale quantification, with 1.00=strongly disagree to 5.00=strongly agree. The considered agree-disagree levels are shown in Table 3. FA was carried out to reduce the number of factors by combining data. The one-way ANOVA tests were performed to compare the mean values of the combined factors of IT benefits with regard to the demographic data of respondents and companies (Pallant, 2001).

TABLE 3: Considered Agree-Disagree Level Results from Likert Scale Quantification

Likert Scale	Agree Level
1.00 - 1.50	Strongly Disagree
1.50 - 2.50	Disagree
2.50 - 3.50	Neither Agree nor Disagree
3.50 - 4.50	Agree
4.50 - 5.00	Strongly Agree

7. RESULTS OF THE STUDY

The background information of the respondents and companies are presented in Table 4. The respondents were 29 (28%) project managers, 31 (30%) managing directors, 55 (53%) degree holders, and 52 (50%) individuals with more than ten years of experience in construction. The background information of the construction companies showed that 42 (41%) companies were from the category of building and civil engineering, and 45 (44%) were from the central region (e.g., Kuala Lumpur and Selangor). The best fit to technical requirements was a common method of IT evaluation in companies and 42 (41%) companies used this method. Furthermore, 72 (70%) companies were investing $\leq$ 5% of their total investments in IT, whereas 47 (46%) companies invested RM 2,500-12,000.

TABLE 4: Background information of the respondents

Variable	Frequency (n=103)	Percentage (Total=100%)
Occupation		
IT User	27	26.2
Engineer	16	15.5
Managing Director	31	30.1
Project Manager	29	28.2
Education level		
Diploma	29	28.2
Bachelor	55	53.4
Post graduated	19	18.4
Experience		
<5	20	19.4
5 -10	31	30.1
>10	52	50.5
Category of company		
Mechanical and Electrical	9	8.7
Building	25	24.3
Civil Engineering	17	16.5
Building and Civil Engineering	42	40.8
Building, Civil Engineering and Mechanical and Electrical	10	9.7
Region		
Central	45	43.7
Northern	25	24.3
East Coast	11	10.7
Southern	11	10.7
Borneo	11	10.7
Method of IT evaluation		
Cash Flow Analysis	14	13.6
Best Fit to Technical Requirements	42	40.8
Fit to Investment Requirements	23	22.3
Undefined	24	23.3
Percentage of investment %		
<1	36	35.0
1 - 5	36	35.0
6 - 10	13	12.6
11 - 20	8	7.8
Undefined	10	9.7

Variable	Frequency (n=103)	Percentage (Total=100%)
Amount of investment		
RM < 2,500	7	6.8
RM 2,500 - 12,500	47	45.6
RM 15,000 - 25,000	14	13.6
RM 27,500 - 50,000	10	9.7
>RM 50,000	13	12.6
Undefined	12	11.7

The low percentage and amount of IT investment may be due to the fact that the cost of updating or improving an IT system or a network is low when an IT system is already in place. Accordingly, the respondents gave an indication that the use of IT in construction companies is low. The methods of IT evaluation in 24 (23%) companies were not defined. The same issue were presented in the percentage of IT investment and the amount of IT investment with 10 (10%) of the companies and 12 (13%) companies, respectively, did not define the percentages and amounts of IT investment. The high percentage of undefined areas gave an indication of the lack of awareness regarding IT investment issues in these companies.

The DS results for IT benefits in construction companies are shown in Figure 2. Two groups of values for IT benefits are described. The first group consists of reported Likert Scale (0.00) values for improving management (4.08), competitiveness advantages (3.97), improving business success criteria (4.09), improving information quality (3.94), improving organization growth (3.88), improving work relationships (3.64), and reducing working time (3.75). These results are between 3.50 and 4.50, which represent levels of "Agree" according to the Likert scale. The second group of IT benefits included the following scores for client satisfaction (3.13), cost reduction (2.96), increasing responding rate (3.42), increasing work flexibility (3.49), and increasing market share (3.42). These values are between 2.50 and 3.50, which represent the boundaries of "neither agree nor disagree" Likert scale levels.

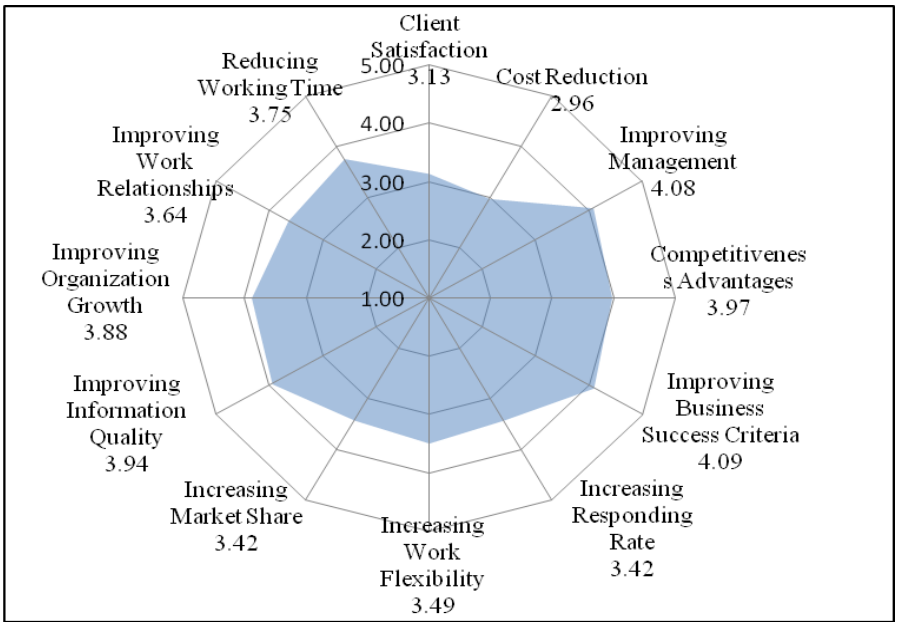

FIG. 2: Mean Values of IT Benefits for Responded Companies

The 12 IT benefits were subjected to Principle Components Analysis *(*PCA) using SPSS software. Prior to performing PCA, the suitability of the data for FA was assessed. Inspection of the correlation matrix revealed the presence of many coefficients at 0.3 and above; for example, the Kaiser-Meyer-Oklin value exceeded the recommended value 0.6, and the Barlett's Test of Sphericity reached statistical significance, which supported the factorability of the correlation matrix (Pallant, 2001). The PCA revealed the presence of three components with Eigen values exceeding 1, namely 48.285%, 13.406%, and 9.547% of the variance, respectively, as shown in Table 5.

TABLE 5: Total Variance Explained by Principle Components Analysis of IT Benefits

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.794	48.285	48.285	5.794	48.285	48.285
2	1.609	13.406	61.691	1.609	13.406	61.691
3	1.146	9.547	71.238	1.146	9.547	71.238
4	.906	7.547	78.785			
5	.734	6.116	84.901			
6	.483	4.025	88.926			
7	.366	3.051	91.977			
8	.349	2.911	94.888			
9	.212	1.769	96.657			
10	.180	1.504	98.161			
11	.140	1.169	99.330			

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.794	48.285	48.285	5.794	48.285	48.285
2	1.609	13.406	61.691	1.609	13.406	61.691
3	1.146	9.547	71.238	1.146	9.547	71.238
4	.906	7.547	78.785			
5	.734	6.116	84.901			
6	.483	4.025	88.926			
7	.366	3.051	91.977			
8	.349	2.911	94.888			
9	.212	1.769	96.657			
10	.180	1.504	98.161			
11	.140	1.169	99.330			
12	.080	.670	100.000			

To aid in the interpretation of these three components, varimax rotation was performed. The rotation results are presented in Table 6.

TABLE 6: Components of IT Benefits by Varimax Rotation for Responded Companies

Items of Benefits	Component		
	1	2	3
Competitiveness Advantages	0.842		
Improving Information Quality	0.842		
Improving Data Management	0.832		
Improving Organizational Growth	0.827		
Improving Business Success Criteria	0.822		
Reducing Time of Project Work	0.759		
Improving Work Relationships	0.754		
Increasing Market Share	0.727		
Increasing Responding Rate	0.535	0.716	-0.362
Increasing Work Flexibility	0.531	0.689	-0.411
Client Satisfaction		0.387	0.638
Reducing Cost		0.451	0.608

IT benefits were classified into three groups, namely improving management, increasing flexibility, and increasing profits, as presented in Table 7.

TABLE 7: Factor Names of IT Benefits According to Benefit Items in the Questionnaire

Factor of Benefits	Item of Benefits
Improving Management	Improving Data Management
	Competitiveness Advantages
	Improving Business Success Criteria
	Increasing Market Share
	Improving Information Quality
	Improving Organizational Growth
	Improving Work Relationships
	Reducing Time of project work
Increasing Flexibility	Increasing Responding Rate
	Increasing Work Flexibility
Increasing Profits	Client Satisfaction
	Cost Reduction

The reported mean value for improving management was 3.85, which falls under the “Agree” Likert scale level, while values for increasing flexibility and increasing profits were 3.45 and 3.04, respectively, as shown in Table 8. These results are between 2.50 and 3.50 on the Likert scale, which represent the boundary area for “neither Agree nor Disagree”.

TABLE 8: Average Mean Values of IT Benefits for Responded Companies

IT Benefit	No. of respondents	Avg. Minimum Mean	Avg. Maximum Mean	Avg. Mean	Avg. Std. Deviation
Improving Management	103	3.42	4.09	3.85	0.92
Increasing Flexibility	103	3.42	3.49	3.45	1.03
Increasing Profits	103	2.96	3.13	3.04	1.00
Total Benefits	103	2.96	4.09	3.65	0.95

In this research, the significance level was set at $p < 0.05$ and a series of one-way ANOVA tests were performed, as shown in Tables 9, 10, 11, and 12, to investigate the hypothesis that there were no significant differences between the mean values of the scores for improving management, increasing flexibility, and increasing profits with regard to the specifications of respondents and companies. According to Pallant (2001), the variances are homogeneous if the significant values of Levene's test are greater than 0.05. For the IT benefits test, since the significant values were greater than 0.05, the homogeneity of variance assumption was not violated. The results of the one-way ANOVA tests showed that there were no significant differences.

TABLE 9: Results of ANOVA Tests for Benefit of Improving Management with Regard to Demography

Demography		N	Mean	Std. Deviation	Results of ANOVA
Respondent Position	IT User	27	30.37	6.17	F(53.11, 35.06) = 1.51 P = 0.22
	Engineer	16	33.62	3.98	
	Managing Director	31	29.94	6.96	
	Project Manager	29	30.45	5.32	
	Total	103	30.77	5.97	
Respondent Education	Diploma	29	29.10	8.23	F(57.57, 35.15) = 1.64 P = 0.20
	Bachelor	55	31.55	4.91	
	Post graduated	19	31.05	4.20	
	Total	103	30.77	5.97	
Respondent Experience	< 5	20	29.10	3.43	F(48.83, 35.33) = 1.38 P = 0.26
	5 - 10	31	31.55	6.22	
	>10	52	31.05	6.49	
	Total	103	30.77	5.97	
Company Category	Mechanical and Electrical	9	27.67	9.58	F(37.25, 35.52) = 1.05 P = 0.39
	Building	25	31.00	3.81	
	Civil Engineering	17	31.71	6.48	
	Building and Civil Engineering	42	30.43	6.05	
	Building, Civil Engineering and Mechanical and Electrical	10	32.80	5.03	
	Total	103	30.77	5.97	
Company Region	Central	45	30.09	7.52	F(20.35, 36.21) = 0.56 P = 0.69
	Northern	25	32.12	5.09	
	East Coast	11	29.73	3.90	
	Southern	11	31.18	2.60	
	Borneo	11	31.09	4.70	
	Total	103	30.77	5.97	

TABLE 10: Results of ANOVA Tests for Benefit of Increasing Flexibility with Regard to Demography

Demography		N	Mean	Std. Deviation	Results of ANOVA
Respondent Position	IT User	27	5.85	1.46	F(4.10, 2.46) = 1.66 P = 0.18
	Engineer	16	6.62	1.41	
	Managing Director	31	5.74	1.77	
	Project Manager	29	6.38	1.52	
	Total	103	6.09	1.58	
Respondent Education	Diploma	29	5.55	1.94	F(1.03, 2.54) = 0.40 P = 0.67
	Bachelor	55	6.33	1.36	
	Post graduated	19	6.21	1.47	
	Total	103	6.09	1.58	
Respondent Experience	< 5	20	5.80	1.51	F(4.30, 2.44) = 1.76 P = 0.14
	5 - 10	31	6.16	1.44	
	>10	52	6.15	1.71	
	Total	103	6.09	1.58	
Company Category	Mechanical and Electrical	9	5.78	0.97	F(37.25, 35.52) = 1.05 P = 0.39
	Building	25	6.80	1.38	
	Civil Engineering	17	5.94	1.60	
	Building and Civil Engineering	42	5.88	1.77	
	Building, Civil Engineering and Mechanical and Electrical	10	5.70	1.34	
	Total	103	6.09	1.58	
Company Region	Central	45	5.98	1.74	F(2.39, 2.52) = 0.95 P = 0.44
	Northern	25	6.48	1.36	
	East Coast	11	5.64	1.57	
	Southern	11	6.45	1.37	
	Borneo	11	5.73	1.62	
	Total	103	6.09	1.58	

TABLE 11: Results of ANOVA Tests for Benefit of Increasing Profit with Regard to Demography

Demography		N	Mean	Std. Deviation	Results of ANOVA
Respondent Position	IT User	27	6.81	1.94	F(1.02, 4.10) = 0.25 P = 0.86
	Engineer	16	7.25	1.73	
	Managing Director	31	6.74	2.11	
	Project Manager	29	6.97	2.15	
	Total	103	6.90	2.00	
Respondent Education	Diploma	29	6.55	2.43	F(2.99, 4.03) = 0.74 P = 0.48
	Bachelor	55	7.11	1.81	
	Post graduated	19	6.84	1.83	
	Total	103	6.90	2.00	
Respondent Experience	< 5	20	7.10	1.89	F(1.26, 4.07) = 0.31 P = 0.73
	5 - 10	31	7.03	2.06	
	>10	52	6.75	2.04	
	Total	103	6.90	2.00	
Company Category	Mechanical and Electrical	9	6.89	1.83	F(5.83, 3.94) = 1.48 P = 0.21
	Building	25	6.20	1.89	
	Civil Engineering	17	7.06	2.28	
	Building and Civil Engineering	42	7.02	2.05	
	Building, Civil Engineering and Mechanical and Electrical	10	7.90	1.37	
	Total	103	6.90	2.00	
Company Region	Central	45	6.62	2.28	F(4.20, 4.00) = 1.05 P = 0.39
	Northern	25	7.20	1.76	
	East Coast	11	7.09	1.81	
	Southern	11	7.73	1.68	
	Borneo	11	6.36	1.80	
	Total	103	6.90	2.00	

TABLE 12: Results of ANOVA Tests for Overall IT Benefits with Regard to Demography

Demography		N	Mean	Std. Deviation	Results of ANOVA
Respondent Position	IT User	27	43.04	7.37	F(97.89, 55.02) = 1.78 P = 0.16
	Engineer	16	47.50	5.14	
	Managing Director	31	42.42	9.59	
	Project Manager	29	43.79	5.61	
	Total	103	43.76	7.50	
Respondent Education	Diploma	29	41.21	10.74	F(136.70, 54.68) = 2.50 P = 0.09
	Bachelor	55	44.98	5.34	
	Post graduated	19	44.11	6.24	
	Total	103	43.76	7.50	
Respondent Experience	< 5	20	45.65	5.15	F(45.60, 56.50) = 0.81 P = 0.45
	5 - 10	31	43.52	6.93	
	>10	52	43.17	8.52	
	Total	103	43.76	7.50	
Company Category	Mechanical and Electrical	9	40.33	10.01	F(49.92, 56.54) = 0.88 P = 0.48
	Building	25	44.00	4.36	
	Civil Engineering	17	44.71	6.99	
	Building and Civil Engineering	42	43.33	8.80	
	Building, Civil Engineering and Mechanical and Electrical	10	46.40	6.00	
	Total	103	43.76	7.50	

Company Region	Central	45	42.69	9.49	F(51.59, 56.48) = 0.91 P = 0.46
	Northern	25	45.80	5.60	
	East Coast	11	42.45	2.73	
	Southern	11	45.36	3.88	
	Borneo	11	43.18	7.72	
	Total	103	43.76	7.50	

8. DISCUSSION

The results demonstrate that construction companies have realized the benefits of improving management, competitiveness advantages, improving business success criteria, improving information quality, improving organization growth, improving work relationships, and reducing working time with the project. These results are compatible with findings of previous studies (Andresen et al., 2000; Suwardy et al., 2003; Love et al., 2004; Eadie et al., 2010). Some respondent G7 construction companies have not realized some IT benefits, most likely because of the intangible nature of these benefits. These benefits are client satisfaction, cost reduction, increasing response rate, increasing work flexibility, and increasing market share. However, this study came up with three main groups of IT benefits that serve as clusters of all IT benefits: improving management, increasing flexibility, and increasing profits. The respondents recognized the category of improving management in their companies because this was direct and tangible benefit. This finding matches the study of Suwardy et al. (2003). On the other hand, the respondents did not recognize an increase in flexibility because they had not made full use of the full range of IT capacity, especially in organizational work. However, this finding does not match with the findings of Love et al. (2004). In general, the respondents did not realize an increase in profits because they did not consider that IT was a profitable tool. They primarily looked at direct and tangible profits. Most IT benefits, on the other hand, are indirect and long-term benefits, as classified by Schwegler (2001). However, the overall perception of the respondents regarding IT benefits suggests that they were aware of the benefits of IT, given that all values were in or close to the area of "Agree." However, they are still in the preliminary stage of using IT as previously highlighted by Yusuf and Osman (2008) and Yoke et al. (2002).

9. CONCLUSIONS, LIMITATIONS AND FURTHER STUDIES

The benefits of IT in G7 construction companies can be obtained primarily through office Internet that connects all company computers and that can be used to simplify and speed up data and document sharing. In addition, phones and e-mail also function as connection tools between projects and offices. BlackBerry devices, provided to project managers, resident engineers, and managing directors, can send and receive information via SMS and e-mail. Company headquarters connect with other branch offices, vendors, and developers through the Internet; they commonly use e-mail to communicate.

The study revealed that the realized IT benefits classified into three main groups. The first group constitutes increased work flexibility by allowing users to obtain and exchange documents, data, or information by using local area networks and different types of software programs such as Microsoft Office, AutoCAD, and Primavera. Some G7 construction companies are realizing work flexibility—others are not really recognizing it because of improper IT implementation or insufficient user training.

The second group of IT benefits constitutes increasing profits and reducing the costs. The study found that the G7 construction companies did not consider IT as a profitable investment, but as a tool to solve problems or improve work procedures. Some construction companies recognize an increase in profits from long-term use, but cannot quantify that increase.

The third group of IT benefits constitutes improving management. The research found that all the G7 construction companies recognize that using IT can improve their management process through obtaining and updating documents, data, and information by using cash-flow, project-flow and MS project software.

In summary, this research was limited to G7 construction companies and it was not applied among other grades (G1, G2, G3, G4, G5 and G6). In addition, the population consisted of the contractor companies; therefore it is difficult to generalize the results in other construction organizations. There are no other generalizations for the study because it is limited in Malaysia.

The following are the recommended future studies:

1. A study focused on investing and evaluating the IT project and IT benefits in construction companies.
2. A study of managing IT benefits by adopting a case study method based on the observations in at least ten construction companies to get more real and accurate findings.
3. An empirical study in ICT developer companies targeted at providing IT for the construction industry.

10. REFERENCES

Alshawi S., Irani Z. and Baldwin L. (2003). Benchmarking information technology investment and benefits extraction, *Benchmarking*, Vol. 10, No. 4, 414-423.

Andresen J., Baldwin A., Betts M., Carter C., Hamilton A., Stokes E. and Thorpe T. (2000). A Framework for Measuring IT Innovation Benefits, *Journal of Information Technology in Construction (ITcon)*, 5, 57-72.

CIDB (2008). *Malaysian construction industry directory 2008-2009*, Leisure Communications, Kuala Lumpur.

Eadie R., Perera S., and Heaney G. (2010). Identification of e-procurement drivers and barriers for UK construction organisations and ranking of these from the perspective of quantity surveyors, *Journal of Information Technology in Construction (ITcon)*, 15, 23-43.

Fischer M. and Kunz J. (2004). The scope and role of information technology in construction. *CIFE Technical Report 156*, Civil and Environmental Engineering Dept., Stanford University, Palo Alto, 17p.

Hussan F. G., Khalim A. R. and Ismail A. (2008). An empirical investigation for exploring Information Technology factors and firm performance in Malaysia construction sector, *Proceedings of the Fourteenth Pacific Rim Real Estate Society Conference*, Kuala Lumpur, Malaysia, 1-9.

Jaafar M., Abdul Aziz A., Ramayah T. and Saad B. (2007a). Integrating information technology in the construction industry: Technology readiness assessment of Malaysian contractors, *International Journal of Project Management*, 25, 115-120.

Jaafar M., Abdul Aziz A., Ramayah T., and Saad B. (2007b). Technology readiness among managers of Malaysian construction firms, *Engineering, Construction and Management*, Emerald Group Publishing Ltd. Vol. 14, No. 2, 180–191.

Lederer A. L. and Mirani R. (1995). Anticipating the benefits of proposed information systems, *Journal of Information Technology*, Vol. 10, 159–169.

Lin C. and Pervan G. (2003). The practice of IS/IT benefits management in large Australian organizations, *Information & Management Journal*, 41, 13–24.

Love P. E. D., Irani, Z. and Edwards D. J. (2004). Industry-centric benchmarking of information technology benefits, costs and risks for small-to-medium sized enterprises in construction, *Journal Automation in Construction*, 13, No. 4, 507–524.

Norton D. P. (1995). Managing benefits from information technology, *Information Management & Computer Security*, 3, No.5, 29-35.

Pallant J. (2001). *SPSS survival manual: a step by step guide to data analysis using SPSS for Windows, (Version 10)*, Buckingham: Open University Press.

Peansupap V. (2004). *An Exploratory Approach to the Diffusion of ICT in a Project Environment*, Doctoral Dissertation, RMIT University, Melbourne.

Peppard J., Ward J. and Daniel E. (2007). Managing the Realization of Business Benefits from IT Investments, *MIS Quarterly Executive*, Vol. 6, No. 1, 1-11.

Ramayah T., Jantan M., Mohd R. R. and Siron R. (2003). Technology readiness of owners/ managers of SME's, *Int J Knowl Culture Change Manage*, Vol. 3, 475–486.

Remenyi D., Sherwood-Smith M. and White T. (1997). *Achieving Maximum Value from Information Systems: A Process Approach*, John Wiley & Sons, Chichester, England.

Rogers E.M. (1995). *Diffusion of Innovations, 4th Edition*, New York: The Free Press.

Schwegler B. R., Fischer M. A., O'Connell M. J., Reijo H. and Jarmo L. (2001). Near-, Medium-, & Long-Term Benefits of Information Technology in Construction, *Center for Integrated Facility Engineering*, Working Paper 65, Stanford University, Palo Alto, 17p.

Sekaran U. (2003). *Research methods for business: a skill building approach*, 4th edition, John Wiley & Sons, Inc., USA.

Sommerville J. and Craig N. (2006). *Implementing IT in construction*, Routledge, Taylor & Francis Group, New York, NY.

.

Stewart R. A. (2003). Lifecycle Management of Information Technology (IT) Projects in Construction, *PhD thesis*, Griffith University, Gold Coast.

Stewart R. A., Mohamed S. and Daet R. (2002). Strategic Implementation of IT/IS Projects in construction: a case study, *Journal of Construction Automation*, Vol. 11, No.6, 681-694.

Stewart R. A. (2008). A framework for the life cycle management of information technology projects: ProjectIT, *International Journal of Project Management*, Vol. 26, 203-212.

Suwardy T., Ratnatunga J., Sohal A. S. and Speight G. (2003). IT projects: evaluation, outcomes and impediments, *Benchmarking: An International Journal*, Vol. 10, No.4, 325-342.

Svidt K. and Christiansson P. (2006). Experiences from implementation of ICT for resource management in small construction companies, *World Conference on IT in Design and Construction, INCITE/ITCSED*, New Delhi, Vol. 1, 285-295.

Ward J., Taylor P. and Bond P. (1996). Evaluation and realization of IS/IT benefits: an empirical study of current practice, *European Journal of Information Systems*, Vol. 4, 214-225.

Yoke L. M., Abdul Aziz A., Cheng A. N., Chee W. Y. and Shiau W. L. (2002). A survey of internet usage in the Malaysian construction industry, *Journal of Information Technology in Construction (ITcon)*, Vol. 7, 259-269.

Yusuf S. and Osman O. (2008). An evaluation of the use of Information Technology in the Malaysian construction industry, *Proceeding of ICoPM*, University of Malaya, Kuala Lumpur, 710-718.