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Strategic Management of Information Technology in the Construction Industry: Case Study of a Developing Country

Chandra Bhuta

School of Arch., Civil & Mech. Eng., Victoria University of Technology (Footscray Park Campus), Australia, chandra.bhuta@vu.edu.au

Samir Shah

School of Info. Sciences & Tech., The Pennsylvania State University (York Campus), USA, sns107@psu.edu

M. Sapri Pamulu

School of Civil Eng., Hasanuddin University (Tamalanrea Campus), Indonesia, mspamulu@unhas.ac.id

ABSTRACT

This paper presents findings of a research project, which explores the current use of information technology (IT) in the Indonesian construction industry. The findings are based on a survey questionnaire taken between December 2002 and April 2003 among 250 construction companies registered in the National Construction Industry Development Board (CIDB) of Indonesia. The CIDB has listed and classified these companies as B category or large company. A total of 48 valid replies were received, representing a response rate of 38%. The survey includes IT environment and management use of software, hardware, internet applications, staff competency, investment in IT, benefits gained and problems associated with its implementation, and an assessment of the exploitation of IT for business strategic purposes. The paper also suggests to aggressively pushing for a need for the relevant government initiatives that would increase strategic use and adoption of IT. Government and public agencies should consider policies that encourage the use of IT in the construction industry, thus making this industry sector more competitive.

INTRODUCTION

The issue of technology exploitation, particularly in the field of information technology, is of significant importance in the construction industry. Information technology has created fundamental impact on the ways business processes are carried out. IT can no longer be viewed as an enhancement to traditional business procedures but rather as an innovative agent that enables new and different alternatives to the organizational operations. This new trend will color investment attitudes of business communities in the developing world towards utilization of IT in the coming years.

IT is already widely used in the construction industry and much more dramatic effects are anticipated in the near future. Betts (1999) reported that the construction industries in many countries are seriously starting to consider the strategic use of IT. The use of IT in the construction industry is being expanded beyond the state of piecemeal application to an advanced stage where IT is applied strategically. From strategic point of view, IT has the potential to change the landscape of the construction industry in a developing country.

INDONESIAN CONSTRUCTION INDUSTRY

Although the construction industry in Indonesia is relatively young, it has shown a rapid growth since early 1970s. Its contribution to the Gross

Domestic Product (GDP) has increased from 3.86% in 1973 to 7.94% in 1996. It constitutes about 60% of gross fixed capital formation. The number of people employed in the industry has increased significantly, from about 413,000 in 1978, to about 3.796 million in 1996. The number of construction companies has been steadily increasing between 1992 and 2000 (CIDB 2003).

Indonesia is an archipelago with more than one thousand islands. At present, most of the construction work is carried out in the island of Java and in the capital city, Jakarta. Most of the project planning and design work for these projects is being prepared in Jakarta.

There are many problems which can be solved and savings can be realized with the use of IT. For example, one of the problem areas in this type of work has been identified as the communication in construction (Ganah 2001), which can be improved with the use of IT. Information and Communication Technology undoubtedly has a profound influence on how data and information is transmitted and used by parties involved in the construction industry. Also, as suggested by the Latham report almost 30% cost savings in construction can be realized with the use of IT.

PREVIOUS WORKS

A number of publications concerning IT in the construction industry have been reported in the literature. Many surveys were carried out in various countries such as: Australia (Love 1996, Stewart 1998, Marosszeky 2000, Thomas Ng. 2001), Canada (Rivard 2000), Hong Kong (Shen 1999, Futcher 2000), Ireland (Thomas 1999), Malaysia (Mui 2002), New Zealand (Doherty 1997), Saudi Arabia (Sash 1996, O'Brien 1999), Scandinavia: Denmark, Finland, & Sweden (Howard 1998, Samuelson 2002), Singapore (BCA 2001, Swee-Lean 2003), South Africa (Arif 2003), Taiwan (Tan 1996), Turkey (Isikdag 2002), UK (O'Brien 1991, Ingirige 2001), and US (CFMA 2002), Toole (2003). Due to this significant volume of research, it is important to ensure that the results and findings can be compared and lessons learned can be applied to gain a picture of the growth of IT use in construction.

Most of these publications describe the use of IT in the construction industry in the developed countries. Howard (2003) stated that IT products such as software are available worldwide, but may not fit into certain industries in a developing country which are organized in a traditional way and do not have the same drive towards process improvement. Stewart (2002) reported that construction organizations operating in developing countries face further distinctive difficulties, such as: scarcity of IT professionals, inadequate physical and informa-

tion infrastructure, social and cultural diversity, and political barriers that modulate, and distort competitive markets.

RESEARCH OBJECTIVES AND METHODOLOGY

The study of this paper focuses on investigating the current state of Information Technology use in the construction industry, more specifically, to obtain an up-to-date and general view of the state of IT use in Indonesia. The survey includes IT environment such as hardware, software, networks, staff competency, and IT investment. It attempts to measure the resulting benefits and associated problems, and provides an assessment of the exploitation of IT for business strategic purposes.

The mailing list for the survey distribution was obtained from the National Construction Industry Development Board (LPJK/CIDB) in Indonesia. The survey recipients were mainly in the capital, Jakarta area for the following reasons: (1) about 30% of construction projects in Indonesia were located in the Greater Jakarta area, (2) most of the projects, especially public work projects, were planned and designed in Jakarta, and, (3) most of the construction participants - owners, designers and contractors - have their headquarters or representatives in Jakarta. The mailing list consisted of a total of 247 large construction companies representing all national companies which operate throughout Indonesia. This includes a group of 130 randomly selected construction companies, which received this questionnaire. Of these, 20 mails were returned undelivered and or declined to participate. A total of 48 organizations (44 % of those delivered) returned the questionnaire.

RESULTS AND FINDINGS

(A) Characteristics of Respondents

The companies represented in this survey have a workforce between 1 and over 200 employees. Over one third of the respondents have over 200 employees.

The respondent companies in terms of number of employees are shown in Table 1. Most of the respondent companies are involved in civil, electrical and mechanical construction works. Over 90% of all local companies are involved in civil construction business. Of all international respondent companies 64% have engineering business (Electrical and Mechanical Engineering), and 59% of them compete with the local firms in civil construction

The majority of the organizations had annual revenue of more than 6 billion Rupiah (Rp.) (US \$ 666,697). A quarter of organizations had an annual turnover between Rp. 1-5 billion (US \$ 111,111 - \$ 555,556), and about 12.5 % organizations had an annual turnover of less than US \$ 111,111. Thus, based on this sample, most contracting firms in Indonesia is classified by CIDB as "B" Class, which means a big company. These companies could be undertaking projects with minimal value of US \$ 1.1 million. In the highest category of revenue there are 45% of all multinational companies and 42 % of all local companies that had revenue of more than US \$1.1 million.

Table 1. Company Size (number of employees)

Number of Employees	1-10	11-50	51-100	101-200	>200
Percentage	2.1%	29.2%	12.5%	18.8%	37.5%

Table 2. Respondent Organization's Annual Revenues (size)

Annual Revenue	<US\$0.1M	US\$0.1-0.6M	US\$0.6-1.1M	>US\$1.1M
Percentage	12.5%	25.0%	18.8%	43.8%

Table 3. Level of Spending on IT

Summary	Single respond		Multiple Responses	
	Freq.	% Respond	Cases	% Responses
#18. IT Expenditures/Investments of Overall Exp./Inv.				
< 5 %	25	52.1		
6 - 10 %	15	31.3		
11 - 20 %	4	8.3		
21 - 30 %	4	8.3		
>30 %	0	0.0		
Total	48	100.0		

(B) IT Investments

This section presents an overview of the IT environment within the following topics: General IT Investment, IT Related Expenditures, and Reasons for Investing on IT.

General IT Investment

The amount of company funds spent on IT area has always been controversial. For many years it has been thought by some executives that too much has been spent and there has been insufficient return from this IT expenditure.

In terms of spending on IT, by looking at the current picture, most firms (83 %) spend less than 10 % of their overall expenditure on investments in IT. 16% of the companies surveyed spend more than 10 % on IT. In addition, 86 % of multinational firms spent less than 10% of their total expenditures, which is slightly more than local companies (78%), on IT.

IT Budget Distribution

From the available budget for IT expenditure, the firms tend to spend most of it on hardware and peripherals (98%). As new computer related products have a very short life, the pressure to upgrade will only increase. Supporting software to operate the latest hardware generates an 88% of the budget in spending.

However, the proportion of training and manpower costs is well below the hardware, software, and networks management costs. The survey was not just "yes" or "no" question, but a check list so that companies can mark any item of identified cost.

Interestingly, with the emphasis on upgrading the systems, IT manpower and training takes up the fourth and fifth places in budget priority. There seems to be a disparity on having the latest in hardware and software without the necessary adequate and/or trained personnel to operate it.

Reasons for Investing on IT

The motivation for investing in IT seems to be initially for proficient technical work, followed by management control and reporting, demand from employee (internal purposes). Innovation appears to be at the bottom in reasons for investing on IT.

(C) Level of IT Use in Business Process

With so many potential strategic applications for IT in business, it becomes important to find a means of classifying the role played by IT within an organization's business processes. To enable such classifica-

Table 4. IT Budget Distribution

Budget/Costs	Hardware	Software	Network	Training	Manpower	Others
Percentage	98%	88%	50%	40%	29%	6%

Table 5. Reasons for Investing on IT

Reasons	Responses
Desire to make technical work more efficient	81%
Demand for management control and reporting	67%
Efficient	65%
Demand from employees	60%
Desire to stay ahead of competition	58%
Demands from clients/customers	50%
Strategic decision from company management	42%
Desire to make administrative work more	33%
Demand for business sustainability	33%
Exploitation and Innovation of new and latest technology	29%

Table 6. IT Self-Assessment Matrix

IT Level	Characteristics
5 Integrated	IT plays a vital role in your business activities and is integrated with your clients and business partners IT systems
4 Strategic	Your business employs IT as part of overall business strategy. IT used to analyze and improve business activities
3 Planned	Your business has a program for IT investment and implementation. The application support business activities and tend to be working satisfactorily
2 Responsive	Competitors or software vendors govern IT implementation. IT is used primarily when asked by clients and partners
1 Occasional	Your business has limited understanding of value and potential of IT. It is dependent on individuals buying hardware and software for their own needs
0 Not Used	Your business does not use IT to support its activities

tion, Construct IT – University of Salford, United Kingdom, developed matrix was used. The matrix classifies the IT use under one of the six levels.

In this case, business processes have been defined as processes that cut through the entire organization to exist as a business entity. Betts (1999) outlines a definition of generic business processes in construction enterprises as below:

- *Business Planning*: refers to strategic management of the organization, deciding on new business ventures, and other senior management functions.
- *Marketing*: refers to market selection, public relation activities, market intelligence, and generating new business.
- *Information management*: refers to communications links between parts and locations of the business and external organizations, information achieving and distribution, and activities in information processing. It also includes information strategy and system planning.
- *Procurement*: refers to all activities associated with the involvement of the organization in the procurement activities of the client or customer and to the activities associated with procuring the services and activities of other participants to the organization's input to the project. *Finance*: refers to activities associated with financial management and transaction processing on projects and at head office within organization
- *Client Management*: refers to activities associated with managing relationships with customers, both on specific projects and in longer-term relationships.
- *Design*: refers to those activities concerned with obtaining a brief, conducting feasibility studies, and sketch and detailed design activities undertaken on projects.
- *Construction*: refers to those activities associated with production support on projects and extends into commissioning.
- *Occupation and maintenance*: refers to activities associated with the use and occupancy, and maintenance phases of buildings and projects.

Table 7. IT Use in Business Processes

Business Processes	Total Score
Business Planning	4.58
Marketing	4.00
Information Management	3.67
Procurement	3.67
Finance	3.19
Client Management	2.90
Design	2.75
Construction	2.60
Occupation & Maintenance	1.44
Human Resources	0.73

- *Human Resources*: refers to activities within the organization and on its projects that concern the management of people.

The Porter's Value chain models (Porter 1980) can also to be adapted to the construction industry, where business processes divide into two categories:

- *Core activities*: refers to processes associated with business planning include design, construction operations include planning & scheduling, Operation executions and client services follow-up include client management.
- *Supporting activities*: refers to processes associated with human resources, procurement, finance, IT and other technology application and development, and marketing.

The following sequences describe the methodology adopted in assessing the level of IT use in different business processes in construction organizations.

- Use questionnaire results related to three typical benefits gained in the previous section to find out the role played within construction organizations. Betts (1999) provided a useful checklist of typical benefits in relation to business processes.
- Rank business processes and the classify into core activities and supporting activities
- Use the self-assessment matrix to assess the level of IT use.

The results of the above assessment are shown in Table 7.

Table 7 shows construction organizations in Indonesia use IT mostly in processes related to information management, occupation and maintenance management, and business planning. IT has made little difference in human resources of the business and marketing process. Overall, IT has been employed in core activities rather than supporting activities within business process. However, the level of usage is still very low. From this evidence, it may be surmised that Indonesian construction companies are not yet in a strategic position to exploit capacity of IT. It can be said to be in planned level where the applications support business activities.

CONCLUSION AND RECOMMENDATION

This research provides a picture of the current state of Information Technology applications among Indonesian contractors. The following conclusions can be made based upon our results and analysis of the surveys:

Indonesian construction industry is deploying the latest computer hardware and software. However, the industry does not yet have sufficient adequate and trained personnel to fully exploit the advantage of the new technology. Our survey indicates that only 15% of organizations who possess a high level of computer competencies.

On the other hand, general administration works have been mostly computerized. Drawings, scheduling, book-keeping, costing, invoicing, and project management tasks are well computerized. Interestingly, tender preparation, bill of quantities, material control, technical calculation and engineering analysis are partly manual and partly computerized.

Economic and risk analysis which is mostly used in the business planning process is largely untouched by information technology. Internet and Web-based technology have been introduced to the industry, but few companies employ it in e-Business and trading.

In terms of IT spending, most firms (83%) spend less than 10% of their overall expenditure on IT-related investments. This problem is probably associated with the lack of management support for IT applications. At present, the main motivation for investing in IT appears to be in attempting to improve technical work. Innovation appears to rank low as a reason for investing in IT. From the strategic point of view, the Indonesian construction industry is still operating in a traditional manual manner and has failed to gain full advantage from the new technology because of human and organizational issues.

RECOMMENDATIONS

The research has identified a number of areas that could be improved in order for the Indonesian construction industry to take full advantage of information technology. Some additional recommendations for the government, CIDB and companies include the following:

- Indonesian government can consider policies that encourage the use of IT in the construction industry, thus making this sector more competitive internationally.
- Public agencies such as CIDB can encourage the construction industry to make greater use of IT, such as SIMPRO that was developed by CIDB.
- Companies should continue to improve the use of IT by making sure that there is sufficient trained staff for the implementation of IT policies and IT applications.

FURTHER WORK

The survey was confined to only one sub-sector (large contractors) of the Indonesia construction industry in Jakarta. Other sub-sectors such as small and medium firms should be a part of future surveys. This being the first published survey of this type in Indonesia, a full study in greater breadth and depth would be highly beneficial for this important sector of a developing country's economy.

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