

Managing Information Technology in Construction: Case of the Turkish Construction Industry

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Abstract

Effective IT implementation in construction is necessary to improve productivity; however the uptake of IT applications has been limited. This paper explains the results of a research that aimed to investigate the current state of IT in the Turkish construction industry. For this purpose, a questionnaire survey of 84 contractors was conducted. The survey includes the use of software, hardware, expertise, and benefits gained and problems associated with its implementation. It is encouraging to see that most of the respondents reported that they exploited IT in their business processes, which mainly include; accounting, design/drawing, tender preparation and bidding, costing/budgeting, technical calculations/engineering analysis, material purchasing, general administration, and project management. The survey results revealed that the use of IT raises the following benefits for companies; ease of monitoring the progress of the ongoing projects, ease of capture of meaningful information, enhanced competitive advantage of the company, faster delivery of services, and ease of document tracking and management. Despite these advantages, there are some barriers to the extensive use of IT, which include; lack of trained personnel, lack of knowledge, rapid changes in technology, unawareness about the capabilities of the available technologies, and lack of top management support. The paper suggests that all the relevant parties should do their part in order to increase strategic use and adoption of IT in the construction industry.

Keywords

Information technology, Construction industry, Management, Application, Turkey

1. Introduction

The construction industry and its activities have an important role in socio-economic development, environment, and quality of life. In contrast to its significant impact on national economies and people's lives, the construction industry is one of the slowest sectors to integrate technological advances such as information technologies (IT), computer-aided construction, automation, etc. due to the peculiarities of the industry (UNEP Report, 2002).

It is commonly acknowledged that effective IT implementation in construction improves productivity (Stewart *et al.*, 2004). However, the adoption of IT applications and tools in construction is very slow and limited, especially when compared to the other industries. The reasons behind this slow uptake include the very nature of how the industry constructs one-off projects creating a project rather than a process perspective of production and of investment opportunity, supply chain fragmentation, lack of client leadership, low level of technology awareness and training, necessary up-front investment, on-going maintenance costs and resistance to change (e.g., Fink, 1998; Marsh and Flanagan, 2000; Mak, 2001; Stewart *et al.*, 2002; Stewart *et al.*, 2004; Love *et al.*, 2005). Yet, contractors have recently begun to

exploit information technologies in their business because of the fact that the use of these technologies promises several advantages such as faster delivery services, reducing lead times for financial reporting, easier international links, better control of cash flow, etc. (Pamulu and Bhuta, 2004).

Sarshar and Isikdag (2004), Acar *et al.* (2005), and Tas and Irlayici (2007) examined the ICT capabilities and the extent to which these technologies are actually used in the Turkish construction industry. They found that the information technologies are not effectively used in the Turkish construction industry and the Turkish construction industry faces similar challenges as other countries.

This study aims to investigate the current state of IT in the Turkish construction industry. For this purpose, a short questionnaire was designed and conducted among 84 construction contracting companies.

2. Research Methodology

In order to investigate the extent to which Turkish construction companies exploit information technologies in their business process, a questionnaire survey, which consists of 21 questions, was conducted as the research instrument as in the similar study carried out by Pamulu and Bhuta (2004). The data has been collected via mail, e-mail, and fax. The contact persons were top managers. The research sample was mainly drawn from the companies registered in the Turkish Contractors Association (TCA).

TCA was founded in 1952 to represent the leading construction companies in Turkey. According to official figures obtained from the website of TCA (www.tmb.org.tr), Turkish contractors have completed over 4,300 projects in 69 countries since the early 1970's and their business volume abroad has reached approximately \$105 billion. TCA has currently 143 members and their business volume constitutes nearly 70% of national and 90% of international contracting work done so far by Turkish construction companies.

The questionnaires were sent to the randomly selected 100 construction companies registered in TCA. In addition to these 100 construction companies, 50 large-scale construction companies were included in the survey. Of the 150 questionnaires that were sent, 84 were returned duly filled out, which corresponds to a response rate of 56%.

The questionnaire consisted of two main sections. The first section included five questions, which inquired about the context of the respondent company. The second section comprised sixteen questions. These questions focused on exploring the current state of IT in the Turkish construction industry.

Questions 1 to 5 record the general characteristics of the respondent company such as number of technical personnel, total turnover, type of work (i.e., building, civil, industrial, or other type), client profile, and existence of a quality assurance system.

Questions 6 to 21 aim to find out the construction company's attitude towards information technologies and the extent to which these technologies were exploited. These questions ask about the use of hardware, software, expertise, and benefits gained and problems associated with its implementation.

3. Discussion of Findings

3.1 Characteristics of Respondents

General characteristics of the respondent construction companies should be considered when interpreting the survey results. Drawing responses from a wide range of construction companies was necessary in order to reflect the actual state of the Turkish construction industry. The companies should have a balanced dispersion and there should be enough numbers to represent each group. Table 1 summarizes the general characteristics of the respondent construction companies. Responses were drawn from small-scaled construction companies employing less than 50 technical personnel to large-scaled construction companies employing over 100 technical personnel.

Table 1: Number of Technical Personnel

Number of Technical Personnel	Frequency (%)
1-49	38
50-99	19
>100	43

The respondent companies range from those with total turnover between \$0-50,000,000 to those with over \$500,000,000 (see Table 2).

Table 2: Respondent Company's Total Turnover

Total Turnover (\$ Millions)	Frequency (%)
0-50	36
50-100	16
100-200	10
200-500	8
500-1.000	19
>1,000	11

Overall, 92% of the respondents were involved in building work alone or building work in addition to civil, industrial or other types of work, while the remaining 8% were not involved in building activities. 68% of the respondent companies' clients were mainly from private sector and 69% of the respondent companies utilize a quality assurance system.

3.2 Current Usage of IT

In order to find out construction companies' attitude towards information technologies and the extent to which they exploit these technologies, 16 questions were asked to the respondents. These questions were about the following topics: hardware, software, expertise, and IT barriers and benefits.

3.2.1 Hardware

The answers of the respondents to the question inquiring about the number of computers owned by their company are shown in Table 3. As shown in Table 3, 43% of the respondent companies own 1 to 10 computers, whereas 8% of the respondent companies own more than 500 computers. It should be noted that the number of computers per employee might have been a more meaningful measure; however, since the relevant question did not focus on exploring such information, the number of computers owned by the respondent company was used as a measure.

Table 3: Number of Computers Owned by the Respondent Company

Number of Computers	Frequency (%)
1-10	43
11-50	25
51-100	17
101-200	2
201-500	5
>500	8

When the respondents were asked whether they had networked computers or stand alone computers, the majority of the respondents (81%) reported that they had networking within their organization (see Table 4).

Table 4: Hardware Profile of the Respondent Company

Hardware Profile	Frequency (%)
Networked Computers	58
Stand Alone Computers	19
Both	23

3.2.2 Software

When the respondents were asked whether all the computers owned by their company had internet access, all of the respondents stated that they did. The large majority of the respondent companies (74%) had an official website, and 75% of the respondent companies that have a website reported that their company's website was regularly updated. When the respondents were asked whether they utilized e-commerce applications, it was interesting to see that 69% of them reported that they did not.

In order to investigate the use of information technologies in the business processes of the respondent companies, they were asked about the types of software applications. Table 5 indicates that more than half of the surveyed companies exploit information technologies in accounting (71%), design/drawing (59%), tender preparation and bidding (59%), costing/budgeting (57%), technical calculations/engineering analysis (54%), material purchasing (52%), general administration (51%), and project management (51%). Only 14% of the respondents use software applications in risk analysis.

Table 5: IT Applications in Business Processes

Application Fields	Frequency (%)
Accounting	71
Design/Drawing	59
Tender Preparation and Bidding	59
Costing/Budgeting	57
Technical Calculations/Engineering Analysis	54
Material Purchasing	52
General Administration	51
Project Management	51
Bill of Quantities	47
Invoicing	40
Scheduling and Resource Planning	37
Document Tracking and Management	35
Specification Writing	31
Risk Analysis	14
Other	4

Respondents were asked about the computer programs which were used by their company. The computer programs used by the respondent companies in different application fields including drawing/design, technical calculations/engineering analysis, and project management are summarized in Table 6. 87% of the respondent companies use AutoCAD in design/drawing, 26% of them use SAP2000 in technical calculations/engineering analysis, and 51% of them use MS Project in project management.

Table 6: Computer Programs Used by the Respondent Companies

Application Fields	Computer Programs	Frequency (%)
Design/Drawing	AutoCAD	87
	Autodesk 3ds MAX	23
	AutoCAD Civil 3D	14
	AllPlan	12
	NetCAD	12
	ArchiCAD	11
	Revit Architecture	10
	AutoCAD LT	1
	IdeCAD (Architectural)	1
	Other	4
Technical Calculations/Engineering Analysis	SAP2000	26
	Sta4CAD	25
	IdeCAD (Static)	11
	XSteel	6
	Probina	2
	Etabs	2
	StaadPRO	0
	Other	6
Project Management	MS Project	51
	Primavera	26
	Power Project	14
	SureTrak	5
	AMP	5
	Open Plan	4
	Project Commander	2
	Other	8

When the respondents were asked whether they used bespoke software within their company, 26% of them stated that they did. The companies that use bespoke software were also asked about the business processes in which they use those programs. The application fields of the bespoke software used by the respondent companies are shown in Table 7. Based on the survey results, the respondents predominantly use the bespoke software in technical calculations/engineering analysis (45%), document tracking and management (41%), accounting (36%), and material purchasing (36%).

Table 7: Use of Bespoke Software in Business Processes

Application Fields	Frequency (%)
Technical Calculations/Engineering Analysis	45
Document Tracking and Management	41
Accounting	36
Material Purchasing	36
General Administration	32
Invoicing	32
Costing/Budgeting	32
Bill of Quantities	32
Project Management	27
Tender Preparation and Bidding	23
Design/Drawing	18
Scheduling and Resource Planning	14
Specification Writing	14
Risk Analysis	14
Other	14

3.2.3 Expertise

To explore the level of expertise in information technologies currently available in construction companies, contractors were asked if they employed personnel who are specialists in these technologies. 51% of the respondents reported that they did. When the respondents were asked whether they conducted ICT training for their employees, 68% of them stated that they did not. When the companies were asked about the proportion of trained personnel, 81% of the respondents reported that more than 50% of their personnel have some form of formal computer training (see Table 8).

Table 8: Proportion of Trained Personnel

Proportion of Trained Personnel	Frequency (%)
1-10	7
11-20	4
21-30	2
31-40	2
41-50	4
51-60	6
61-70	4
71-80	7
81-90	16
91-100	48

The respondents were also asked if they believed the academic curricula in universities provided adequate education about information technologies from the hardware and software standpoints. The survey results indicated that the majority of the respondents (83%) believed that the academic curricula in universities do not provide adequate education about information technologies.

3.2.4 IT Barriers and Benefits

In order to identify the factors preventing the extensive use of information technologies in the Turkish construction industry, the construction companies were asked about the barriers to the use of IT. Table 9 indicates that lack of trained personnel, lack of knowledge, rapid changes in technology, unawareness about the capabilities of the available technologies, and lack of top management support are perceived as the most important barriers to the extensive use of information technologies in Turkey.

Table 9: Barriers to the Use of IT

Barriers	Frequency (%)
Lack of Trained Personnel	88
Lack of Knowledge	87
Rapid Changes in Technology	80
Unawareness about the Capabilities of the Available Technologies	76
Lack of Top Management Support	75
High Costs	57
Integration/Compatibility Problems	35
Software Problems	29
Hardware Problems	27
Security Problems	15

The construction companies were asked about the benefits they gained from the use of information technologies. Table 10 indicates that ease of monitoring the progress of the ongoing projects, ease of capture of meaningful information, enhanced competitive advantage of the company, faster delivery of services, and ease of document tracking and management are perceived as the most important benefits that may be gained by the effective use of IT.

Table 10: Benefits Gained by the Use of ICTs

Benefits	Frequency (%)
Ease of Monitoring the Progress of the Projects	98
Ease of Capture of Meaningful Information	95
Enhanced Competitive Advantage of the Company	93
Faster Delivery of Services	90
Ease of Document Tracking and Management	89
Easier Communication	86
Reduced Lead Times for Financial Reporting	83
Less Paperwork	82
Easier International Links	79
Better Control of Cash Flow	77

4. Conclusions

It is commonly acknowledged that effective use of information technologies promises several advantages to the construction companies. However, the uptake of IT in construction has lagged well behind most other industries due to the very nature of the industry. Yet, contractors have recently begun to exploit information technologies in their business. This study aimed to investigate the current state of IT in the Turkish construction industry through a survey of 84 construction contracting companies.

The survey results revealed that 43% of the respondent companies own 1 to 10 computers, whereas 8% of the respondent companies own more than 500 computers. 81% of the surveyed companies have networking within their organization. All of the computers owned by the surveyed companies have internet access. The large majority of the respondent companies had an official website, and 75% of these respondent companies regularly update their company's website. Only 31% of the surveyed companies utilize e-commerce applications. Most of the respondent contractors exploit IT in their business processes, which mainly include; accounting, design/drawing, tender preparation and bidding, costing/budgeting, technical calculations/engineering analysis, material purchasing, general administration, and project management. 87% of the respondent companies use AutoCAD in design/drawing, 26% of them use

SAP2000 in technical calculations/engineering analysis, and 51% of them use MS Project in project management. 26% of the surveyed companies use computer programs specially written for their company. The respondents predominantly use the specially written programs in technical calculations/engineering analysis (45%), document tracking and management (41%), accounting (36%), and material purchasing (36%).

The survey results indicated that the use of IT raises the following benefits for companies; ease of monitoring the progress of the ongoing projects, ease of capture of meaningful information, enhanced competitive advantage of the company, faster delivery of services, and ease of document tracking and management. Despite these advantages, there are some barriers to the extensive use of IT, which include; lack of trained personnel, lack of ICT knowledge, rapid changes in technology, unawareness about the capabilities of the available technologies, and lack of top management support.

It appears that information technologies have become widespread in the Turkish construction industry. However, there are still some barriers to the extensive and effective use of these technologies at all level. The survey results revealed that all the barriers are related to the lack of training and top management support. Undoubtedly, top management's commitment to the extensive use of IT is vital. Moreover, awareness of both prospective and active professionals about information technologies would help in disseminating the use of IT. Prospective engineers' knowledge about these technologies can be provided via architecture/engineering curricula in universities by developing new courses in civil engineering and architecture programs and specialty training in master's programs to teach these technologies. Active professionals' familiarity with these technologies may be fostered via companywide training programs, continuing education courses, or more extensive endeavors. All the relevant parties should do their part in order to increase strategic use and adoption of IT in the construction industry.

This study is of benefit to the participants of the construction industry, because it helps them to understand the main reasons that prevent the use of information technologies, it makes them aware of the problems, and it guides them in eliminating the barriers to the deployment and dissemination of IT.

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