The Use of Information Technology Techniques in the Construction Industry of Pakistan

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ABSTRACT

Construction sector together with service, manufacturing, agriculture and mining sectors is the main contributors of the Pakistan's GDP (Gross Domestic Product) and economic growth. It is also a key indicator in determining the economic performance of the country. As the issues of globalization and trades deregulation, stringer requirements of time, cost, quality and advancement of technologies have become more critical, the sector has to find ways to enhance its operational efficiency and effectiveness. IT (Information Technology) as a key enabler has been recognized to be an inseparable tool to sustain business and become more competitive. This paper gives an overview of the current status of IT application and presents the significant results from PCI (Pakistan Construction Industry). The result of survey also highlights the challenges to the construction industry of Pakistan before implementing the IT techniques. A statistical method 'Average Index' is used to analyze the collected data and statistical hypothesis testing is conducted to know the difference between the parameters. The survey produced knowledge about the use of computers, hardware and software, communication and strategies for the use of IT. The use of spread sheets, word processor, CAD (Computer Aided Drafting) in general has increased and the use of model based CAD software has increased among the major key players of construction industry. The use of project webs and electronic trade in the industry is not started properly. From the analysis it is concluded that construction firms in Pakistan are mostly using manual procedures and the use of IT seems to be at the inception stage.

Key Words: Information Technology, Pakistan Construction Industry, Questionnaire Survey.

1.   INTRODUCTION

Bjork [1- 2] defined IT as the use of electronic equipments and software for the processing, storage, transfer and presentation of information. Computers are now a vital part of all effective businesses [3]. IT is revolutionizing the way people share information and documents. In today's construction industry, IT techniques must be viewed as potential resources. Soetanto, et. al. [4] described that appropriate use of advanced IT will help to achieve performance efficiency and effectiveness in the construction process. Marsh, et. al. [5] listed that the industry is yet to realize full benefits from IT utilization. Memon, et. al. [6] mentioned that CIC (Computer Integrated Construction) is an emerging technology and it is an approach to assist construction firms for responding to the difficult environment in which they are working.

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To promote the application of IT techniques within construction firms of Pakistan, Government of Pakistan has started taking efforts by developing IT policy for construction sector. PCI master plan framework 2005-2015 that outlined IT as a key critical success factor with the following objectives:

(i)   Promoting continuous education to enhance and encourage competency skills, which relate to information and communication technology.

(ii)   Developing a construction industry knowledge community by exploiting information technology.

The Pakistan Engineering Congress, Pakistan Engineering Council and Ministry of Information Technology are trying in their way to bring revolution in construction sector of Pakistan but results are not so much fruitful. An inquiry of statistics in the construction industry of Pakistan is led by author and discovered that no official figures published about the use of IT tools in the construction sector of Pakistan. Several surveys have been conducted to determine the impact of Information Technology in the construction industries of different countries conducted by O'Brien, et. al. [7], Howard, et. al. [8], Futcher, et. al. [9-10]. The survey presented in this paper is aimed to investigate the use of IT techniques in the construction industry of Pakistan. In order to achieve this aim, the survey looked at various aspects related to the use of IT in construction organization of Pakistan. The findings of the study will help in forming the strategies that will be beneficial for the development of this industry in Pakistan.

2.   QUESTIONNAIRE SURVEY

The main purpose behind the questionnaire survey is to determine the use and penetration of IT techniques in the construction industry of Pakistan. The result of survey will help to develop a solid platform for professionals and researchers to investigate the issues regarding the implementation of Information Technology techniques in the construction industry of Pakistan. The questionnaire survey is aimed to collect representative data from the industry to update the existing knowledge and to re-evaluate the extent of the problem as it stands to date. Hence, the questionnaire was set up to obtain professional opinions on the following aspects:

(a)   Availability and Usage of Computers.

(b)   Network and Communication techniques.

(c)   Importance of Internet.

(d)   Use of Engineering Analysis Software.

(e)   Electronics Documents.

(f)   Impact of IT applications in construction industry of Pakistan.

The further discussion for the design of questionnaire survey and distribution of questionnaire form are discussed in the following sub-section.

3.   DESIGN OF QUESTIONNAIRE SURVEY FORM

The questionnaire survey form was designed to know the professional approach towards the application, existing practice and future related to implementation of Information Technology Techniques in the construction sector of Pakistan. While designing the questionnaire form, considerations have been taken for the aim and objectives of the study, with an intention to provide sufficient background and to obtain professional opinions from the industry to cover the issues that are within the limitation of this research work. From detail literature review, result of a series of discussion with professionals, unstructured interview with the clients, consultants, architects and contractors a questionnaire survey form was designed to know the impact of IT in PCI. The questionnaire survey form is divided into two major sections. First section enquired the introductory information of firm and second section investigates the different issues for application of IT in PCI.

4.   METHODS OF ANALYSIS

It is important to consider at early stage the method of analyzing before developing any system of data collection. The reason for this being that the method of analysis determines type of data to be collected and structure of questions. One of the scientific methods that have been widely used to test hypothesis is considered for this study. The type of data collected appropriately follows the measurement or scaling used to define a variable quantitatively. The data collected for this questionnaire survey was analyzed using the Average Index Method or Mean Score. The same method was used and discussed by Assaf, et. al. [11], Chan, et. al. [12], Majid, et. al. [13], Al-Harty, et. al. [14], Memon, [15], and Akhtar, et. al. [16] to establish average index for the different factors. The five point Likert Scale for example, 1=very low and 5= very high or something similar are normally employed in collecting data to prove a predetermined hypothesis.

In order to combine the opinion of the respondent groups, the agreement between rankings of any two groups for any given number of factors need to be tested. Assaf, et. al. [11] and Majid, et. al. [13], Al-Harty, et. al., [14] categorized the Spearman's rank correlation coefficient to measure the association between two groups of respondents and the variables were measured in an ordinal scale. This coefficient is the oldest and best known as rank correlation coefficients. The values of Spearman's rank correlation coefficient can be in the range of (-1<Rs<+1) and when the value is zero implies an absence of any correlation. If the values are nearly positive one, it indicates a strong correlation and a negative correlation indicates an opposite rank in between two respondent groups. To test the rank correlation coefficient a null hypotheses test was conducted. Al-Harthy, et. al. [14] analyzed his data by using t-statistic test and this study also use that test to identify the level of significance.

The significance of using ranking method is to show the top choice which then can be suggested to higher authorities to incorporate for policy making for the

application of IT techniques in construction industry. Where appropriate a statistical test was conducted to reaffirm and support the participant view. If a null hypothesis is rejected it indicates that there is a significant agreement in the ranking which determined at 95% confidence level. This shows that there is an agreement in the ranking between both groups of respondents. But if there is no significant agreement, the contractor ranking can still validate and establish the finding of this study.

5.   RESULTS AND DISCUSSION

In order to achieve the aim and objectives of this study, professionals from different construction organization were contacted through the postal address and personal contact. In order to develop the result of this study, a total of one hundred seventy five questionnaire survey forms were posted or given to respondent personally. A total of fifty questionnaire survey forms (29%) were received fully filled. The total maximum response came from contractor organization (58%) where as consultant group rated second (42%). Fig. 1 shows the graphical presentation of respondent organization and their distribution profile according to their professional experience in the field of construction.

The results of the questionnaire survey are presented in the following sub-sections. The main purpose of conducting survey and analyzing the data is to know the Level of Information Technology techniques in the Pakistan Construction Industry.

5.1   Computer Usage

In the modern era computers are generally used for many purposes. This section surveyed the usage of computer in different sections of an organization. Computer usage is surveyed for the use of different office software such as word processor, spread sheets, etc. The survey is also looked for the usage of computer for design and drafting, project planning and scheduling, tendering and purchasing, costing and budgeting and general

administration purposes. Table 1 summarizes the results and highlight the average mean score and rank given by participants for the computer usage. The highest ranked factor is the most frequently use of computer for the contractor and consultant organizations. From the analysis it has been observed that the use of computer for spread sheets, designing and drafting is comparatively higher than other factors. The table 1 also highlights the comparison between contractor and consultant responses. The contractors group ranked 'Spread Sheets' as the best use of computer followed by design and drafting and bill of quantities. Mean-while the consultants group ranked word processor as the best use of computer. The difference in the top ranked indicators between both groups may be due to the differences in the priority of the project objectives. The correlation test conducted on both groups of

FIG. 1. TYPE AND DISTRIBUTION PROFILE OF RESPONDENTS

respondents gives the Spearman's Coefficient, rho, (R_s) of 0.168 and significant from two tail statistical test, t-cal. (t-calculated) is 0.614, which is less than 95% confidence level value from t-table, which is 1.73. The null hypothesis H0 is not significant agreement in the ranking between contractor and consultant groups is thus accepted. From the analysis it can be concluded that there is a difference in ranking between the contractors and consultants response, however the objective to determine the more use of computer has been achieved. The contractor response has established and validated the objective of using the computer more in contractor organizations.

5.2   Network and Communication

The initiation of networks and internet provide extraordinary opportunities to construction firms for effective communication and data exchange. Table 2 shows the calculated value for the spearman's correlation coefficient. This indicates that there is almost an agreement in the ranking between the respondents groups. The significance value is very close to the significance level of 95%. The null hypothesis H_0 is within significant level, so the respondent agree in the ranking between contractor and consultant groups is thus accepted. Participants agreed to each other for using mobile phone, landline connection and fax machine for the communication.

Respondents were asked separately for the benefits and disadvantage for using internet as a communication tool. Tables 3-4 show the results of benefits and disadvantage of using Internet as communication tool. From the calculated values respondents almost disagree with each other for benefits which can be observed after using Internet as a main communication tool. For the result of disadvantages for using internet as a communication tool, consultant and contractor slightly dis-agree the issues with appears after using Internet as a tool. The difference in opinion of the two group of respondent is due to the business objectives involved in the successful completion of project.
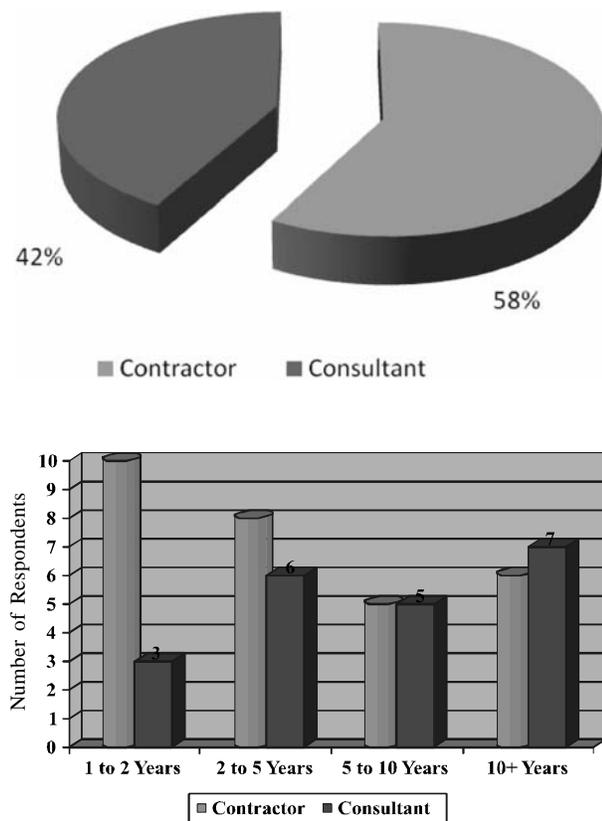
5.3 Use of Engineering and Management Software

After getting information regarding network and telecommunication, respondent were asked to score the importance of different software used in their organization. The out put of this survey as shown in Table 5; for consultants firms; they prefer to use software for Design and Analysis and CAD for drafting, however, the contractors prefer to use CAD for drafting and management software for planning, monitoring and controlling. The table 5 also highlights the comparison between contractor and consultant responses. The contractors group ranked 'CAD' as the best use of Engineering and Management software followed by Management and then design and analysis software. However, the consultants group ranked design and analysis software is the best use of engineering and management software. The difference in the top ranked indicators between both groups is due to importance of software for their organizational objectives. The correlation test conducted on both groups of respondents gives the Spearman's Coefficient, rho, (R_s) of 0.400 and significant from two tail statistical test, t-cal. are 0.617, which is less

TABLE 1. COMPUTER USAGE IN PCI

No.	Computer Usage	Contractor		Consultants		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Spread Sheet	4	1	4.267	2				
2.	Design & Drafting	3.864	2	4.067	3				
3.	Bill of Quantities	3.864	3	3.333	14				
4.	Book Keeping	3.818	4	3.4	11				
5.	Technical Calculations	3.773	5	3.533	10				
6.	Data Basis	3.591	6	3.687	8				
7.	Costing & Budgeting	3.591	7	3.867	4				
8.	Material Control	3.455	8	3.8	6	0.168	0.614	1.73	FALSE
9.	Project Planning	3.318	9	3.8	5				
10.	General Administration	3.273	10	3.133	15				
11.	Site Management	3.136	11	3.4	12				
12.	Word Processor	3.091	12	4.6	1				
13.	Purchasing	3.091	13	3.333	13				
14.	Scheduling	2.909	14	3.667	9				
15.	Tendering	2.409	15	3.733	7				

TABLE 2. NETWORK AND COMMUNICATION

No.	Network & Communication	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	tcal.	tstatistic (t-Table)	Reject H_o
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Landline Connection	4	2	4.6	1				
2.	Mobile	4.091	1	4.333	2				
3.	Fax Machine	3.182	3	3.667	3	0.886	3.816	1.943	TRUE
4.	Having your own web-page	2	5	2.8	4				
5.	Cordless	2.455	4	2.333	5				
6.	Pager	1.682	6	1.6	6				

than 95% confidence level value from t-table, which are 2.132. The null hypothesis H_0 is not significant agreement in the ranking between contractor and consultant groups is thus accepted. From the analysis it can be concluded that there is a difference in ranking between the contractors and consultants response, however, the objective to determine the frequently use of engineering and management software has been achieved. The contractor response has established and validated the objective of frequently using the engineering and management software in contractor organizations.

5.4 Transfer of Documents in Electronic Forms

As it was already discussed that respondents prefer to use spread sheets and word processor as a part of computer usage in the firm. In the continuity of that respondents were asked to highlight the importance of keeping the docume nts in electronic forms. The order of preference viewed from the survey as shown in Table 6 reveals that consultants and contractors prefer to keep past record in electronic form; similarly the technical

T.ABLE 3. BENEFITS OF USING INTERNET

No.	Benefits	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Time Saving	3.545	1	3.467	3	0.257	0.532	1.943	FALSE
2.	Cost Saving	3.409	2	2.6	5				
3.	Improve Efficiency	3.364	3	4	1				
4.	Reduction of Employees	3.273	4	3.4	4				
5.	Expand Business	3.227	5	3.8	2				
6.	Obtain Project	2.636	6	2.467	6				

TABLE 4. DISADVANTAGE OF USING INTERNET

No.	Disadvantage (Disadvantage of Using Internet)	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Frequency in Line Cut-Off	3.591	1	3.2	2	0.543	1.293	1.943	FALSE
2.	Virus Problem	3.318	2	3.2	1				
3.	Difficulty in Getting Connected	3.182	3	2.8	5				
4.	Security Problem	3.091	4	2.933	4				
5.	Error in Sending and Receiving Mail	3	5	2.8	6				
6.	Downloading Problem	2.955	6	3.067	3				

TABLE 5. RESULT OF USE OF SOFTWARE

No.	Disadvantage (Disadvantage of Using Internet)	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Management	3.591	2	3.2	3	0.400	0.617	2.132	FALSE
2.	Design & Analysis	3.318	3	3.2	1				
3.	Computer Aided Drafting (CAD)	3.182	1	2.8	2				
4.	Geographical Integrated Software	3.091	4	2.933	4				

calculations such as drafting of design or survey information also in the electronic form. The contractors and consultants group ranked 'Past Record' as the best use of transferring Documents in Electronic Format. Respondents also agreed the benefit which can be achieved after transferring documents into electronic format is technical calculation. The main reason of agreement between respondent groups is that it reduces the paper work technical calculation can be easy carried and cross checked. It also helps the parties for the future business in construction industry.

The correlation test conducted on both groups of respondents gives the Spearman's Coefficient, rho, (R_s) of 0.796 and significant from two tail statistical test, t-calculated, is 4.176, which is less than 95% confidence level value from t-table, which is 1.782. The null hypothesis H0 is not significant agreement in the ranking between contractor and consultant groups is thus rejected.

5.5 IT Techniques in Construction Industry of Pakistan (Impact, Barriers and Future Plan)

The construction sector is quite heterogeneous and very different from other sectors. Therefore, it is difficult to evaluate, while considering the implementation of IT in the construction sector. The respondent from construction industry of Pakistan is asked for the Impact of IT, Barriers in implementing IT and what they have future plan for implementing IT in their organization. Tables 7-9 shows the result of survey for implementing IT in construction industry. From the result of spearman correlation between the respondent group, it can be summarized that they agree with each other for the Impact, Barriers and Future Plan for the use of IT in Construction Industry of Pakistan.

6. CONCLUSIONS

Based on the results of the survey, the conclusions are given in this section.

(i)   It is clear from the survey that computers are now an essential part of business within most of the construction organizations. It is clearly indicated from the analysis that all the respondents replied in affirmation about the computer availability. The usage of computer is limited for spread sheets, design and drafting, however for the business process such as administration, tendering, scheduling, purchasing, etc is rare. This level of computer usage concludes that most of the construction firms in Pakistan are using manual procedures and the use of computers seems to be very less.

TABLE6. ELECTRONIC DOCUMENTS

No.	Electronic Documents	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Past Records	3.773	1	4.333	1				
2.	Technical Calculations	3.545	2	4	2				
3.	Construction documents	3.182	7	4	3				
4.	Specifications	3.455	3	3.867	4				
5.	Design Documents	3.227	6	3.8	5				
6.	Agreements	3.136	8	3.733	6	0.797	4.176	1.782	TRUE
7.	Achievements	3.318	4	3.6	7				
8.	Company Statistics	2.818	9	3.4	8				
9.	Tender Enquiry	2.5	10	3.2	9				
10.	Future Plans	3.273	5	3.133	10				
11.	Order Invoices	2.364	11	3	11				
12.	Minutes of Meeting	2.045	12	2.667	12				

(ii)   Majority of the respondents use mobile and landline connection as a major tool for communication; however construction firms are adopting Internet as a communication tool for management. The firms of most respondents have an idea that by using Internet as a communication tool they can save time, cost and improve efficiency of daily construction activities. In developing countries like Pakistan, normally internet users face line cut-off problems, so they are worried about using internet as communication tool. It is also observed from the survey that only 22% construction companies have their own web page for the business purpose, rest 78% companies don't have the webpage.

TABLE 7. IMPACT OF IT

No.	Impact of IT on Construction Industry	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Design	3.955	1	4.267	1				
2.	Planning	3.955	2	4.067	2				
3.	Quality of Work	3.682	3	3.533	12				
4.	Proportion of New Operation	3.636	4	4.067	3				
5.	Administration Needs	3.591	5	3.667	6				
6.	Finance & Accounts	3.545	7	3.667	7				
7.	Speed of Work	3.545	6	3.4	13				
8.	Communication	3.455	8	4	4	0.525	2.138	1.761	TRUE
9.	Controlling	3.391	9	3.667	8				
10.	Mistakes in Documents	3.364	10	3.6	11				
11.	Monitoring	3.318	11	3.667	9				
12.	Product Models	3.091	12	3.733	5				
13.	Complexity of Work	3.045	13	3.267	14				
14.	Construction Errors	2.955	14	3.667	10				

TABLE 8. BARRIERS IN IMPLEMENTING IT TOOLS

No.	Barriers to Computer Use in Construction Company	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H_0
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Investment Cost Too High	3.409	3	4	1				
2.	Lack of Standard & Co-ordination Problem	3.273	6	3.733	2				
3.	Lack of Finance	3.318	4	3.533	3				
4.	Decision Makers Have No Time for IT Efforts	3.318	5	3.533	4				
5.	Continue Upgrade of Hardware & Software	3.636	1	3.467	5				
6.	Adequate Awareness of Current System	3.636	2	3.333	6	0.673	1.818	1.796	TRUE
7.	Lack of Commitment from Management	3	9	3.267	7				
8.	Satisfaction with Present System	3.091	8	3.2	8				
9.	Reduced Security	2.818	11	3.133	9				
10.	Slow Outcome	3.136	7	2.933	10				
11.	Negative Outcome	2.955	10	2.333	11				

(iii) The use of different engineering and management software is a critical part of implementing IT tools for construction firms. CAD software is used by many construction firms to produce most of the drawings. With the advance demand of client, now a days many firms are using management software especially Microsoft Project and Primavera Project Planner for planning and scheduling the construction works. The use of software helps the construction firms in keeping the record of past projects in electronic form for the future reference.

(iv) The advent of IT in construction sector of Pakistan is both advantageous and detrimental. According to the respondents, by implementing IT they can improve the productivity especially in planning, design and communication. However, the implementation of IT in country like Pakistan has many barriers such as: high cost, continuous upgrading of hardware and software and greater know-how required from the workforce.

(v) As for as the future investment in the implementation of IT is concerned, the respondents prefer to invest in the communication tools, analysis, design and drafting. By investing in these fields, new design tools would serve the designers during the design stage and the implementation of communication tools will increase the productivity during the execution stage. It will also offer a greater monitoring and control for the successful project management.

(vi) From the analysis of survey, it is concluded that manual operations are more prevalent in the construction organizations of PCI, and the use of IT is very less and seems to be at the inception stage.

7. RECOMMENDATION

There is an immense need of IT strategy plan which can improve the current practices in construction industry of Pakistan. The implementation of IT strategic plan will help in utilizing modern tools of IT, through which the productivity, business process, general administration, design, financial benefits and project management techniques can be improved.

TABLE 9. PLANNED FUTURE INVESTMENT IN IT

No.	Planned Future Investment in IT	Contractor		Consultants & Clients		Spearman's Coefficient (Rs)	t-calculated	tstatistic (t-Table)	Reject H$_0$
	Factors	Average Mean	Rank	Average Mean	Rank				
1.	Mobile System	4.273	1	4.333	1				
2.	CAD	3.909	2	4.267	2				
3.	Document Handling	3.909	3	4.067	4				
4.	Design & Analysis	3.864	4	4.2	3				
5.	Accounting Systems	3.864	5	3.933	6				
6.	Project Management	3.682	6	3.867	8				
7.	Systems for Cost Control	3.409	7	3.867	10				
8.	System for Technical Calculation	3.273	8	3.867	9	0.709	3.332	1.761	TRUE
9.	Electronic Data Interchange	3.273	9	3.2	13				
10.	Portable Equipments	3.227	10	3.733	12				
11.	Budgeting & Costing	3.182	11	3.933	7				
12.	Product Models	3.136	12	4	5				
13.	Project Common Site for Documents	2.63	13	3.8	11				

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