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ANALYSING THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN CONSTRUCTION INDUSTRY

AISWARYA PREMDILIP[1] and DR R.N UMA[2]

[1]PG STUDENT, DEPARTMENT OF CIVIL ENGINEERING, SRI RAMAKRISHNA INSTITUTE OF TECHNOLOGY, COIMBATORE, TAMIL NADU
[2]DR R.N UMA,HEAD OF DEPARTMENT, DEPARTMENT OF CIVIL ENGINEERING, SRI RAMAKRISHNA INSTITUTE OF TECHNOLOGY, COIMBATORE, TAMIL NADU

ABSTRACT: *In the construction industry there is a necessity for improving the construction efficiency through adopting innovative methods. Information and Communication Technologies (ICT) help in increasing the client satisfaction by reducing coordination errors and provide a greater understanding among project participants in terms of better handling issues and requirements. Construction projects are faced with many challenges that must not be ignored or underestimated. Some of the wicked problems and challenges such as understanding how one decision will impact decisions in other areas; problem of addressing the risk due to dynamic and uncertainty existing in the environment; resolving conflict where there are competing claims resulting both good and bad outcomes from the same value system are required to be well managed, if required using innovative methods such as using ICT and software packages. Therefore Objective of this research is to explore and describe the use and applications of information and communication technologies in construction industry. It involves examining the current trends of ICT based construction practices and also to assess the potential for its improvement by way of innovation.*

Key Words: Construction industry, ICT, Challenges, Innovative methods, Innovation

1. INTRODUCTION

The cultural context of construction projects has changed in recent years creating a more complex business environment. One reason behind this is the rapid development of communication technologies. With the increasing need to have immediate information and flexible working practices in a global market, information transfer tends to be electronic. This enables increased volume of information transfer dependent on the time zone. These information and communication technologies (ICT) have encouraged geographical dispersion and a retreat from face to face contact with more asynchronous communication.

Information and communication technology (ICT) is defined and discussed differently in construction writings as the actual hardware employed to perform a basic information processing task. Also take the view that communication within organizations and between them is concerned with the exchange of information and the management of it. The different interpretations of ICT have summarized into a flow diagram. Based on this flow diagram, Figure 1 shows the flow of information from a form of communication. There is a need to distinguish between 'information technology' and 'communication technology' since information technology is essential in construction for the storage of information but its use does not necessarily mean communication has to take place.

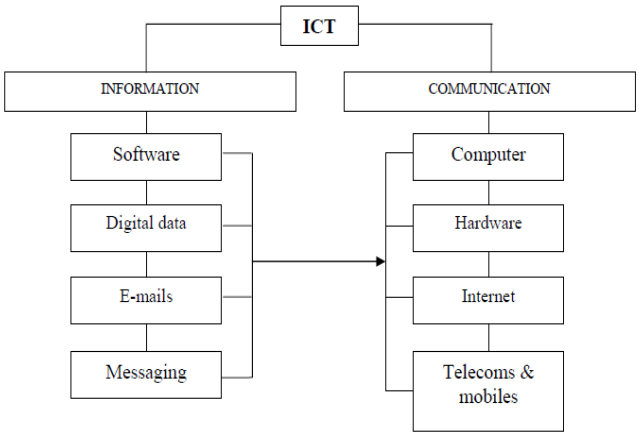

Fig 1 Typical flow of information through a medium of communication

2. Need for ICT in the construction industry

ICT in construction means the adaptation of information communication and technology in construction procedure. ICT in construction can be broken down into different segments for its better understanding and its role in construction.

- Before construction procedure firstly, construction industry participants and organizations communicate with each other and are concerned with information exchange, dealing with drawings, specification, cost estimation and changes in design.
- Communication can include conversation, listening, networking and information collection, mails, using different electronic medium or manual means.
- Technology includes design tools like CAD, SAP, BIM used for design, cost estimation, change in design etc.
- Cost-effectively construction, along with building product customization and differentiation

2.1. ICT tools and applications in the construction sector

Information and Communication Technology (ICT) should support the entire construction process of construction from inception through to the operational maintenance of the building asset. This involves using ICT tools and technology to create, communicate and exchange information and data among the various participants in the project team. Key ICT tools and applications for the construction sector are:

2.1.1 Electronic Communication and Data exchange systems in construction

Computers and web-based technology has offered the potential for great advances in transferring information accurately and quickly, and in some instances, approaching the goal of real time information flows. Indeed, this has made the use of the Internet and computer-aided communication very essential for closer collaboration among construction project partners. Traditional forms of communication in organizations are carried out through face-to-face interaction; paper-based drawings, letters and graphics; through telephone calls. The use of electronic communication is doing similar thing through electronic formats. Electronic communication (e-communication) is a system used as a means of sending or retrieving messages through computers or Internet connections. Now a days ,this includes a multitude of communication tools, ranging from simple forms such as emails to more complex forms, such as electronic document management (EDM)systems, enterprise resource planning (ERP) systems and project planning systems.

2.1.2 The internet and Electronic mails (e-mail)

The Internet has been embraced by the construction companies because it could be used as an efficient tool for communication to bring together the widely dispersed project participants and multinational project teams. The value of the internet to construction companies is mainly derived from its ability to easily connect globally to a vast amount of data which would have otherwise taken much money and time. The main uses of the internet include information sharing, interactions and communications. Electronic mail (e-mail) is perhaps, the most popular use of the internet. Messages and project documents as attached files can be sent by electronic mails to members of a project team at different locations an come with distinct advantage of speed. By this, details of work sections for instance, can be exchanged between architect and contractor.

2.1.3 Electronic Data Interchange (EDI)

Construction projects always involve the collaboration of a multidisciplinary project team located in different parts of a country. Some may be resident on site, others located in an office. The advent of the Internet has greatly enhanced the operational scope of collaboration tools. One example is the application of Electronic Data Interchange (EDI).Electronic Data Interchange (EDI) is the exchange of structured data according to agreed message standards between computer systems. These data transfer is achieved by electronic means without human intervention. Indications are that, Electronic Data Interchange (EDI) has also become a preferred way of compressing and transmitting data between a buying firm and its suppliers in many sectors. Example of EDI application in the construction includes procurement of materials or other project procedures that employ document type processing such as invoices.

3. RESEARCH DESIGN AND DATA ANALYSIS

3.1 Methodology

For the purpose of the study, structured questionnaire was prepared and distributed among the construction contractors. Survey questionnaires are categorized as quantitative research and this was preferred because, quantitative approaches are deemed more specific and result oriented; and involves the collection of numerical data in order to explain, predict, and/or control phenomena of interest. The questionnaire was further divided into four categories; the first category dealt with "General Information" like financial background, years of experience, professional background of respondents and so on. The second category "ICT Infrastructure" was related with the ICT platforms, network platforms, operating systems etc. "Extent of ICT usage comprises the third section, in dealt with the ICT usage by the industries.

The five point likert ordinal scale was used to measure the level of usage by responding firms from "Never" to "Always". The final and fourth category "Factors hindering ICT usage" asked the responding firms to find the reasons hindering the use of ICT in the construction industry. The "SPSS" software was used for the analysis of data and the results are represented in the form of tables and charts.

3.2 Data analysis and results

Concerning the working experience of the companies surveyed, Fig2 shows that 18.33% had worked as contractors in the construction industry for over 15 years, 26.67%between 10-15 years, 51.67% between 5 to 10 years and 5% for less than 5 years. The high representation (50%) of firms with experience in between 5 to10 years is significant to provide some understanding their ICT challenges over these past periods.

Parameter	Percentage
Low	37.0
Medium	56.0
High	7.0
Total	100

Table 1 Extent of current usage of ICT

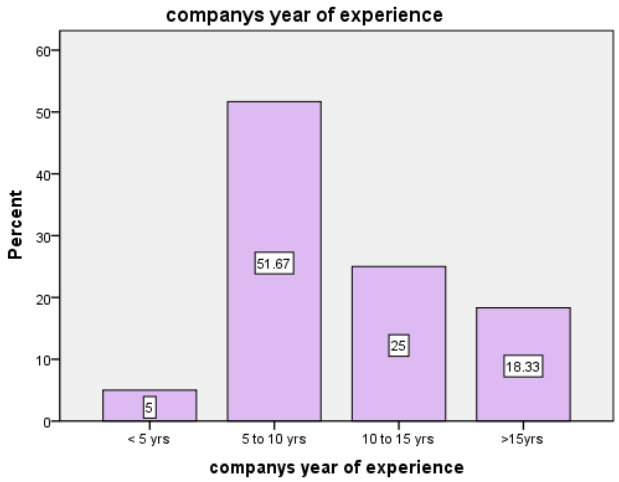

Fig 2 Company's years of experience

On the issue of respondents viewpoint on the extent of current usage of ICT in their firms, Table 4.2 shows a high percentage (56%) of respondents believe their current ICT usage is average while 37% consider their ICT usage as low. Only 7% thought they are using ICT to a high extent in their company. Given the perception of the respondents, there is some level of recognition that their current ICT usage appears ordinary suggesting some aspects for improvements.

The survey further revealed that (Fig 3), about 41.67% of the companies have separate IT division in their organization. A separate IT division within the organization provides an indication of the extent of use of information and communications technology for the day to day activities of that organization.

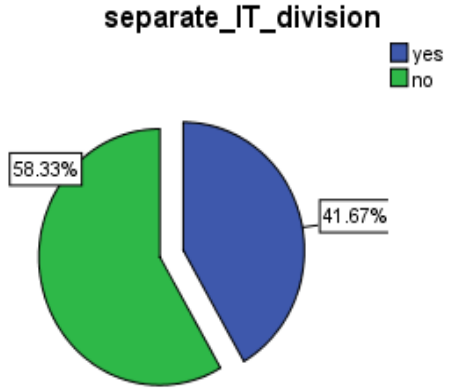

Fig 3 Firms with separate IT division

From table below, it is apparent that the mean response rating for most of the contractors main operations was above average with an overall average mean score of about 3.73. Of the 14 activities stated above, almost half (6 number) had a standard deviation greater than 1.0. This is an indication that, about half of the respondents, had variations in the rating of their level of computerization of their activities while a majority of eight (8) had a standard deviation less than 1.0 indicating some level of agreement among the respondents ratings. According to the survey, the most prominent activities highly computerized/digitize in the respondents organizations are Works Planning and Scheduling (mean=4.472), Book keeping/Accounting (mean= 4.281), Progress Reports (mean= 4.159), Communication with project sites and external parties (mean= 4.196), and Technical Calculations (mean= 3.820). The trend further shows that, computerization of activities such as Costing and Budgeting (mean=3.637), Resource management (labor, Plant and Materials) (mean=3.601), Project Cost Control (mean=3.922), Purchases and Invoicing (mean=3.725) are also above the average value of 3.72. The moderately computerized activities identified by the contractors are Previous project records(mean=2.957), Financial Management(mean=3.236), Distribution of Project documents(mean= 3.21), and while operations and activities such as Site Management and Security

(mean=2.837) were the least rated. Based on the findings presented above, it is reasonable to deduce that, digitalization of the contractors main business activities in a developing area appears quiet high.

Activities	Mean	Rank
Scheduling and works planning	4.472	1
Book keeping	4.281	2
Progress reporting	4.159	3
Communication (with project site &external parties)	4.196	4
Distribution of project documents	4.098	5
Project cost control	3.922	6
Purchases and invoicing	3.725	7
Technical calculators	3.820	8
Costing and budgeting	3.637	9
Resource management	3.601	10
Financial management	3.236	11
Previous project records	2.957	12
Project drawings	2.851	13
Site management and security	2.837	14

By considering usage the range of emerging ICT technologies; the table 3 revealed that current level of usage by the firms was largely below average (Average mean score of 2.27). According to the data, the most prominent ICT application in used was short message Service (mean=4.27) and mobile internet (mean=3.69). Apart from these technologies which were significantly above average, data analysis revealed that the contractors usage of other ICT tools and applications are generally deficient. For instance, usage of applications such as Electronic Purchasing (mean=2.47), Modeling and visualization Technologies (eg.3D-Cad) (mean=2.45), Site Surveillance Technologies (e.g. CCTV) (mean=2.41), Electronic Tendering (mean=2.29), Global Position System (GPS) (mean=2.28), Electronic Document management systems (EDMS) (mean=2.25), Geographic Information System (GIS) (mean= 2.24) were found to be very inadequate and below test level of 3.0. Besides, other tools and applications such as Videoconferencing (mean =1.49), Project specific website/Extranet (mean=1.39), Data conferencing (mean=1.29) and Radio frequency Identification (RFID) / Barcodes (mean=1.12) were basically not used. Drawing from the results above, it is plausible to conclude that more advanced and newer technologies are poorly utilized by contractors. The findings suggest that, while there is some level of awareness about these technologies, the motivation for usage is lacking due to both internal and external constraints.

ICT Applications	Mean	Ranking
Email & SMS	4.274	1
Mobile internet	3.686	2
Electronic purchasing	2.470	3
Modeling and visualization	2.451	4
Gobal positioning system (GPS)	2.411	5
Electronic tendering	2.294	6
Site surveillance technologies(e.g.CCTV)	2.274	7
Electronic document management systems	2.254	8
Geographic information system(GIS)	2.117	9
Video conferencing	1.490	10
Project specific websites	1.392	11
Integrated software (e.g. ERP)	1.294	12
Radio frequency identification & bar codes	1.117	13

Referring to the summary of results, it can be deduced that the most important factors that hindering the use of ICT in the firms are: Budget constraints for ICT investments (Mean=3.6078), Lack of commitment by firm's management towards ICT (Mean=3.5294), Lack of training and technical support for professionals in ICT (Mean =3.4902), Inadequate ICT content of construction education (Mean=3.3333), Majority of client not interested in firms ICT base (Mean= 3.3333), Inadequate knowledge about return on ICT investment (Mean= 3.1765), Rapid changes in ICT technologies (Mean= 3.1569), Cost of implementing ICT in firms (Mean= 3.1373) and High cost of employing ICT professionals (Mean= 3.0588). Notwithstanding the importance of these factors, it is

revealed that the most significant ones among them as reasons hindering the use of ICT by the contractors are:

1. Budget constraints for ICT investments
2. Lack of commitment by firm's management towards ICT
3. Lack of training and technical support for professionals in ICT
4. Inadequate ICT content of construction education
5. Majority of construction clients not interested in firms ICT base

The perception of the respondents also suggests that, their focal concern was budget constraint for ICT investments. This basically agrees with the growing challenge of inadequate funding for major investment activities by contractors. Generally, the cost of implementing ICT is a huge venture and involves both the cost of investment of ICT tools and at the same time the maintenance cost of tools.

The lack of commitment by firm's management towards ICT was ranked second at a significance of (Mean=3.54). This brings to the fore the need to recognize that, effective ICT use will require management focus and leadership commitment on both the technical and organizational aspects for its implementation and use. As a result, the focus on management support for ICT use in an organization is therefore quiet critical.

By ranking the Lack of training and technical support for ICT as the third most significant factor (Mean= 3.490), the studies found that lack of training as a key barrier to adopting and using IT/ICT applications. Traditionally, the emergent problems in learning and training in the construction sectors are quiet significant. This is due not only to the nature of the industry but also to a lack of familiarity with new methods of working. Since training in construction is of strategic importance, the creation of not merely learning organizations, but a 'learning sector' is required.

It is interesting to record that Inadequate ICT content of construction education was ranked fourth at a significant of (Mean=3.33). Basically this may reflects the respondents' strong view of their level of ICT literacy after leaving school. With the view that Majority of client are not interested in firms ICT base, the respondents considered it at a significance level of (Mean= 3.33) and ranked fifth on the scale. Clearly, this finding suggest the need for an increased external requirement where customers/clients may perhaps mandate or look for the availability and use of specific ICT technologies in contractor organizations prior to the award of contract.

4. CONCLUSIONS

Communication Technology (ICT) is well recognized by building contractors as a significant technological spotlight that can help increase the effectiveness of communication and data during the construction process. The study has indeed revealed that, there is a significant level of awareness among the contractors about the potential benefits ICT could offer to their operations. While the use of some selected ICT hardware, notably Desktop PCs, Laptops, digital cameras and mobile phones appears high, more advanced and potable mobile ICT hardware such as Personal Digital assistance (PDA) and Tablet PCs were found deficient. Again, general attitude by the firms towards ICT is positive and this approach may have influenced their confidence to use the technology to various extents. However, current level of ICT usage in general appears to be at a more rudimentary stage consisting of basic hardware and software applications. Though more advanced technical applications of ICT seem to be lacking, most of the firms perceived their current usage of ICT as average.

Though majority of firms were deficient in the use of most advanced ICT tools and applications, the trend is that mobile internet applications and Short Message Services (SMS) through the use of mobile phones were significantly gaining adequate level of usage. As a whole, there appears to be a high level of optimism among the firms that more advanced ICT applications such as Electronic Purchasing, Modeling and visualization (eg.3D-Cad), Project Specific Websites, Electronic Tendering, Videoconferencing and intranets applications could gain some patronage in the near future if the necessary awareness is created.

Finally, it is notable to recognize from this survey that, the most significant factors affecting the use of ICT by building contractors are: Budget constraints for ICT investments, Lack of commitment by firm's management towards ICT, Lack of training and technical support for construction professionals in ICT, Inadequate ICT content of construction education and the fact that majority of client not interested in firms ICT base. These factors should explain the main reason behind current level of ICT usage by among building contractors. It is therefore possible to acknowledge that, whilst the posture and interest towards ICT by building contractors seems promising, these factors continue to be a major issue that stakeholders and

individual organisations need to address in order to increase usage and derive the full benefit of ICT.

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