International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-3, Issue-5, October 2013

Information Technology Training for Construction Industry

Samadhan D. Shelke, Pankaj P. Bhangale

Abstract— Despite the construction industry's generally positive reaction to the use of information and communication technologies (ICTs) in many of its functions, some of the profession's key players reside in a digital divide and do not benefit from advances in technology. The construction workers, an at-risk population with high rates of workplace accidents, are affected by that divide because they rarely take advantage of available ICTs at work. One application of ICTs that can help construction workers is computer-based training (CBT) for occupational safety. However, the design of CBT materials for Indian languages-speaking workers needs to go beyond basic localization of existing products in English. A radical localization approach that uses participatory design sessions with construction workers and their supervisors. The construction workers reacted positively and retained knowledge from CBT materials, including videos with elements of humor and without graphic representations of accidents, modeled after the genre of a television situation comedy.

Keywords — ICTs, IT, CBT, NetsCape, Website, Internet, Usenet.

I. INTRODUCTION

Despite the construction industry's generally positive reaction to the use of information and communication technologies (ICTs) in many of its functions, some of the profession's key players reside in a digital divide and do not benefit from advances in technology. The construction workers, an at-risk population with high rates of workplace accidents, are affected by that divide because they rarely take advantage of available ICTs at work. One application of ICTs that can help construction workers is computer-based training (CBT) for occupational safety. However, the design of CBT materials for Indian languages-speaking workers needs to go beyond basic localization of existing products in English.

The construction workers reacted positively and retained knowledge from CBT materials, including videos with elements of humor and without graphic representations of accidents, modeled after the genre of a television situation comedy. The issue of technology exploitation, particularly in the field of information technology, is of significant importance in construction industry. Information technology (IT) has created fundamental impact on the way business processes are carried out. IT can no longer be viewed as an enhancement to traditional business procedures but rather as an innovation agent that enables new and different alternatives to operation of business organization.

Manuscript received October, 2013.

Samadhan D. Shelke, Department of Civil Engineering, SSGB College of Engineering. and Technology, Bhusawal, District- Jalgoan, State-Maharashtra, India.

Prof. Pankaj P. Bhangale, Department of Civil Engineering, SSGB College of Engineering. and Technology, Bhusawal, District- Jalgoan, State-Maharashtra, India.

This new trend will color investment attitudes of business communities in the world towards utilization of IT in the coming years.

IT is already widely used in construction organizations and much more dramatic effects are anticipated for the years to come. The construction industries in many countries are starting to consider seriously the strategic use of IT. The use of IT in construction is extending beyond the stage of piecemeal application for improving the efficiency of discrete operations by individual organizations to advanced stage where IT is applied strategically in commercial enterprise, government agencies and professional institution. A pragmatist's strategic vision for IT in the construction industry must solve the economic issues. From strategic point of view, IT has the potential to change the landscape of the construction industry

The purpose of this seminar is to study the existing technologies for information exchange in order to devise methods such that these technologies may be used efficiently in the construction industry. The main focus being on the Internet, its available and developing technologies and its implications to and acceptability by the construction industry. The first step will be to discuss the current trends and previous research of the Internet in the construction industry, then to filter out the construction information that can't be computerized and therefore would not be suitable for Internet application and finally to discuss the Internet capabilities and how they can be used to deal with construction information efficiently. The construction industry has always been slow to change, however, the impact that this technology will have on the industry is enormous.

Information technology has grown significantly in the last few years. Today, the Internet is one of the main forms of information technology and is used for accessing, exchanging and communicating information throughout the world. The present information flow system used in the construction industry has several inefficiencies. Errors and misunderstandings occur due to the interpretation and re-entry of data between many of the parties involved in a construction project. This can sometimes lead to extended project completion times and higher costs.

The definitions of "Construction" and "Information Technology" It seems appropriate to start with construction since this is the fundamental activity to which IT techniques are applied. The purpose of construction activities is to produce artefacts such as buildings, process plants, roads and bridges. Civil engineering artefacts are, in contrast to most other manufactured products, located in particular places and need to be constructed on- site rather than in factories. They are also usually one-of-a-kind products. The duration of a construction project is usually long. A comprehensive definition of the construction process should clearly include the whole life-cycle of civil engineering artefacts, including

both design, construction, operation and maintenance. In particular, it is important to stress the inclusion of operation and maintenance since an important part of the information used during these stages originates during design and construction. It is also important to include the manufacturing of the building materials needed as well as public planning and inspection activities, activities which often are overlooked in process models of construction.

Information technology (IT) can be defined as the use of electronic machines and programs for the processing, storage, transfer and presentation of information. In earlier days, when the emphasis was on processing the term electronic data processing, EDP, was common. Nowadays the use of information technology is no longer confined to huge number-crunching machines housed in air-conditioned computer halls but permeates all aspects of everyday life. Communications technology is today an important part of IT. Not only computers and their software, but also devices such as the telephone, the photocopying machine and the telefax should thus be included in our definition of information technology. Many of the functions of these devices are in fact increasingly integrated. With the latest generation of laptop computers it is already possible to send and receive faxes and emails. Recently, mobile phones which incorporate small microcomputers have started to appear on the market.

II. IT TRANSFORMING FOR CONSTRUCTION INDUSTRY

The acceptance of the Internet as an information exchange medium in the construction industry is an important factor and is the focus of this chapter. It is a well known fact that, when compared to other industries, the construction Industry is slow to change. For example, computers have been around for many years and are proven to be efficient tools for better management. Knowing this, there were still approximately 10% of contractors that still did not own a computer. Is this an indication of how the Internet will be accepted by the Construction Industry?

To answer this question, need to look up the past and present trends of the Internet in the Construction Industry. These trends were then used as a tool to project the trends for the future. The articles relating the construction Industry with the Internet were found and documented in the following tables based on the selection of key topics discussed in each article. The key topics are:

KEY TOPICS

Networking for IT training

- 1. Connectivity
- 2. Web sites devoted to the distribution of const. inf.
- 3. Intranets
- 4. Project specific networks or web sites

Software

- 1. Integration of software products
- 2. Internet capabilities and new software

Improvements

- 1. Market potential / Competitive advantage
- 2. Improved communication
- 3. Improved project management

Aspects for training in Construction Industry

- 1. Resistance to change
- 2. Problems with the Internet

III. CONSTRUCTION INDUSTRY TASKS

This chapter focuses on determining what information in the construction industry is Internet compatible and what is not. Set procedures are needed in order for a communications system to work. The standard procedure used today involves passing information on, interpreting that information, reentering it and passing it on again. This procedure is inadequate and the probability for error is high. It is for this reason that new techniques must be developed. "a good system of company communications is essential for smooth and profitable operations." Also, having a good communications system within the company promotes better communication with outside agencies such as owners, designers, general contractors, sub-contractors, insurance companies, banks, suppliers and government agencies.

In order to disseminate the construction tasks as being Internet compatible or not the following three tables were developed. Each table represents a different phase in the construction Industry. A list of construction tasks for each phase was developed and then their compatibility's were determined for the present state, the current capabilities, and for the future (within the next five years).

TASK	PRESENT STATE	CURRENT CAPABILITIES	FUTURE STATE
Develop schedule	No	No	Yes
Provide schedule to all parties	No	Yes	Yes
Update schedule	No	No	Yes
Progress reports	No	Yes	Yes
Other reports e.g. cost control	No	Yes	Yes
Progress meetings	No	Yes	Yes/No
Addendum	No	Yes	Yes
Material procurement	No	Yes	Yes
Material pick up	No	No	No
Equipment Rental	No	No	No
Inspections	No	No	No
Phone conversations (inquiry)	No	Yes	Yes
Mailing objects	No	No	No
Mailing letters	No/Yes	Yes	Yes

Table A : Construction Phase Tasks

TASK	PRES-ENT STATE	CURRENT CAPABIL-ITIES	FUTURE STATE
Feasibility	No	No	No
Create preliminary report	No	Yes	Yes
Create sketches	No	No	No
Send preliminary	No	Yes	Yes
Send preliminary	No	Yes	Yes
Review preliminary	No	Yes	Yes
Review preliminary	No	Yes	Yes
Develop drawings	No	Yes	Yes
Develop specifica-tions	No	Yes	Yes
Develop Eng. Esti-mate	No	No	Yes
Send drawings	No	Yes	Yes
Send specifications	No	Yes	Yes
Send Eng. Estimate	No	Yes	Yes
Accept or reject above	No	No	No
Phone conversations	No	Yes	Yes/No
Mailing objects	No	No	No
Mailing letters	No/Yes	Yes	Yes
Meetings	No	Yes	Yes/No

Table B : Different Design Phase Tasks.

Table B represents the design phase. The list of tasks represent a very general list of the procedure needed to complete this phase. The procedure is a continuous loop of communication until the final set of drawings and specifications have been approved by the owner.

TASK	PRESENT STATE	CURRENT CAPABILI-TIES	FUTURE STATE
Review project delivery	No	No	No
Choose contract type	No	No	No
Develop instr. to Bidders	No	Yes	Yes
Call for tenders	Yes/No	Yes	Yes
GC receives ten-der call	Yes/No	Yes	Yes
GC gets drawings and	No	Yes	Yes
SC gets drawings and	No	Yes	Yes
GC develops quantity	No	No	Yes
SC develops quantity	No	No	Yes
Request inf. from supplier	No	Yes	Yes
Send quantities to supplier	No	Yes	Yes
Supplier devel-ops costs	No	No	No
Supplier sends inf. to C's	No	Yes	Yes
SC develops es-timate	No	No	No
SC sends esti-mate to GC	No	Yes	Yes
GC receives es-timate	No	Yes	Yes
GC chooses SC	No	No	No
GC develops proposal	No	Yes	Yes
GC sends pro-posal	No	Yes	Yes
GC sends bid bond	No	No	Yes
Owner receives proposals	No	Yes	Yes
Owner reviews proposals	No	Yes	Yes
Award contract to lowest	No	No	Yes
GC signs form of	No	No	No
GC requests bond from	No	Yes	Yes
Surety accepts or rejects	No	Yes	Yes
Surety sends bond to	No	No	Yes
Meetings	No	Yes	Yes/No
Phone conversa-tions	No	Yes	Yes/No
mailing letters	No	Yes	Yes
mailing objects	No	No	Yes

Table C : Different Design Phase Tasks.

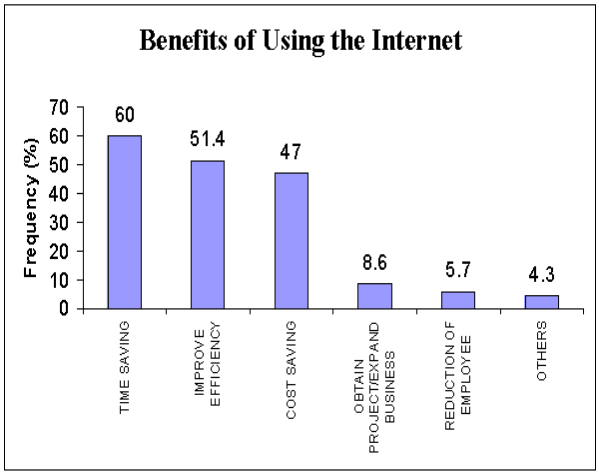
Table C represents the tender phase and table number four represents the construction phase. Each of these lists are also general in nature.

It is important to note that in the design phase, there are only two parties involved in the communication process. In the tender phase and the construction phase all parties become involved and the communication process is much more complicated.

A. Internet Capabilities And There Effects On the Different Tasks

The Internet has many different applications which provide the user with many different communication opportunities. The firms surveyed were asked what were the benefits they received from using the Internet and they were allowed to choose more than one answer that is relevant to them. Below Graph A shows the result. 60% replied that the usage of Internet contributed to time saving in their work. This could be attributed to quick data and information retrieval from the Internet while 51% agreed that the Internet

improved the efficiency of their service. The perceived benefits of IT systems could be summed up as 'greater efficiency' countries where they experienced increase in productivity and where quality of document and speed of work have increased.



Graph A: Benefits of Using the Internet.

47% of the respondents noted that they had gained cost savings after using the Internet in their business dealings. Cost savings due to the usage of Internet could be attributed to the reduction in postal, fax and courier services as documents could now be sent through the Internet, especially for big corporations that has intranets where time and costs are reduced due to shared information among its employees and office branches. 60% of firms make some savings in administration .

In addition, the lack of online discussion/meeting means that the firms were not required to be connected all the time and this again may provide some savings on Internet bills. However, we are unable to determine how significant the cost saving is. Other than the above, 9% of the respondents experienced business expansion and obtained new projects from the usage of Internet. Meanwhile, 5% of the firms surveyed included reduction of employees as one of the benefits from using the Internet. Reduction of employees may also add to the cost saving benefits that some respondents experienced.

The following is a list of the different Internet applications available today.

1) Electronic Mail
2) WWW
3) USENET News Groups
4) Electronic Mailing Lists
5) Interactive Communication On-Line

1. Electronic Mail

Electronic mail is the most common application available today. Every person applying for Internet access is given an Internet e-mail address to begin. This application can be used for common everyday conversation, for long distance letters, for question and answer sessions, for sending attached documents, etc. instantly and at negligible costs. "Why are so many people adopting e-mail? Because it is faster, more efficient, and more cost effective. It is also the application on the Internet with the farthest reach and the greatest number of participants. Using e-mail as a communication tool for the Construction Industry has already begun in some cases. It can replace some phone conversations, can be used to send reports, responses and requests, and can replace the current mailing service for written documents. This service is usually done on a one to one basis.

2. WWW (World Wide Web)

The WWW (world wide web) on the other hand is a place to store information for access by many people. In order for a person to hook up to the WWW, they need an Internet browser application such as Netscape which is usually available from the Internet provider. This application is also being used by many construction industry participants, however not to its full potential. Many firms use this application for marketing purposes in order to provide a competitive advantage over their competitors. However, even in this area, it has not yet been completely accepted by the Industry. It is still primarily used by the larger firms but the smaller firms are becoming more interested and are creating their own home pages as well. Construction information providers, Intranets, project specific web sites and networks for improved communication and project management are all other possible applications of the WWW in the Construction Industry. These have already been discussed in the key topics section of this report and therefore will not be discussed again.

3. USENET

USENET news groups are great applications used for a one to many type of communication. "The Internet permits global collaboration on research projects between many disparate organizations to an extent not previously possible. Setting up a specific news group for important topics within the Construction Industry or within a specific project is just one example of how this application could be used. It would be useful for finding information on the topic, providing information on the topic, becoming up-to-date on the issue or requesting answers to some questions. A project specific web site, for example, may have several forums set up for different topics regarding the project. These forums were used by the project participants when they needed answers, information or wanted to provide information to the rest of the participants. Drawings, change-orders, and safety issues are just a few of the possible topics that could be used as forums for a project.

4. Electronic Mail Lists

Electronic mailing lists are another form of one to many communication. In this case many users are placed on a list and by sending mail to a specific address, all those on the list would receive the mail. This simple application would be great for designers when sending out an addendum about the drawings for example. The designer would be sure that all participants received the addendum as it was in its original state. The problem of receiving, interpreting, re-entering and passing on would be eliminated.

5. Interactive Communication On-line

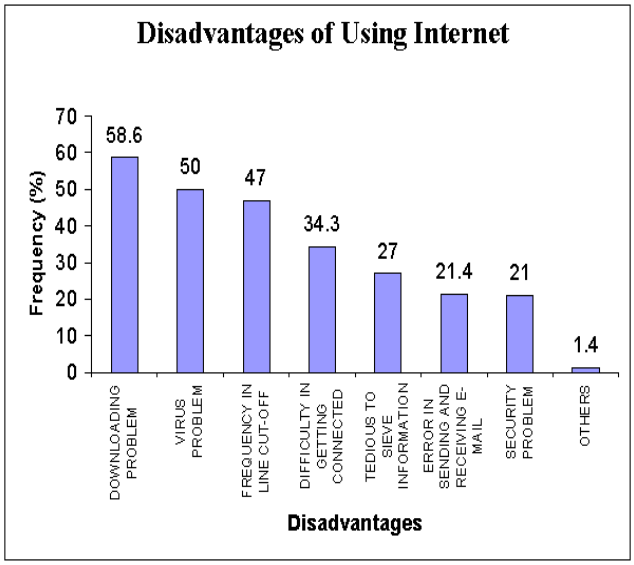
Interactive communication on-line can be a one-to-one, a one-to-many or a many- to-many type of communication. Applications such as IRC (Internet relay chat), CU- SeeMe and Internet Phone are used for this purpose. The IRC is a chat line which allows for people to sign on to a screen that is shared by all participants and to converse using their key

board. The CU-SeeMe application can be compared to a face to face meeting since people can interact with each other through talking and can also see each other using video cameras. The Construction Industry could take advantage of these applications when having meetings or when just having phone conversations. Travel time, travel costs and effective time management are the main savings that would be apparent if these applications were used.

6. Disadvantages of using the Internet

The respondents were asked to indicate the disadvantages that they experienced while using the Internet. Again, they were allowed to give more than one answer.

Below Graph B shows slowness in downloading and transmission of virus is two of the major shortcomings highlighted by the respondent (59% and 50% respectively). As we did not ask the respondents to indicate their hardware capacity's, we would assume that speed of connection and downloading could be improved with better infrastructure and the problem of virus transmission can be arrested by a reliable anti-virus programme most of the time.



Graph B Disadvantages of Using Internet.

The other 47% of the respondents faced connection problems where the major complaint is the difficulty in connection and the frequency of disconnection. This problem could be attributed to the inadequate infrastructure of the Internet Service Provider (ISP). The number of Internet subscribers in India has increased from 13,000 in 1995 to 1.2 million in 2000, contributing to 'traffic congestion' in connecting with the Internet. Six ISPs were granted licences by year 2000 but only three had started to provide Internet access to their subscribers (Eighth India Plan, 2001) and the latest ISP only started operation in 2001.

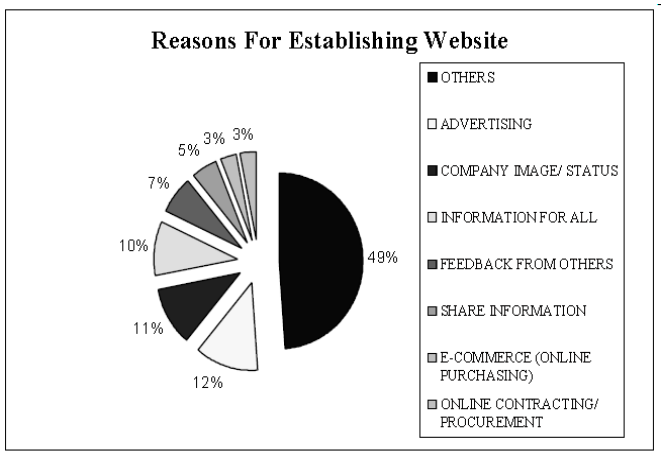
IV. IMPORTANCE OF WEBSITE FOR IT TRAININGS

1. WEBSITE

Out of 70 firms surveyed, currently only 24% have their own website. However, the survey shows that more firms will have their own website in the future as 21% of the respondent indicated that they are planning to have their own website.

2. REASONS FOR HAVING A WEBSITE

Below graph shows the reasons for establishing website.

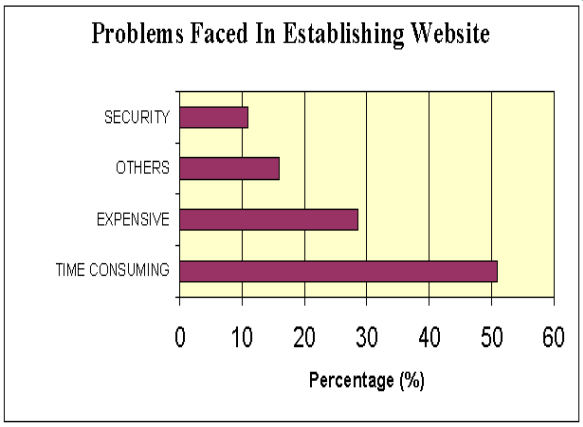


Graph C : Reasons for Establishing a Website.

49% of the respondent did not give any reason for having a website. Given the high percentage, it seems that having one's own website could be due to the 'me too' syndrome. However, further research is required to verify this. From the survey, we found that popular reasons for establishing a website are for advertising (12%), company status (11%) and information for employees (10%). Most firms aim to reach out to more customers through the Internet, as well as to improve the image of the company. It is noted that firms also use the Internet as a means to receive feedback from their customers and to share information. However, the percentages of firms using this method is very small, i.e. 7% and 5% respectively. Feedback from customers is important to the firms as part of their effort to improve performance and service. In terms of e-commerce and online contracting/procurement, the construction industry is still slow in picking up this trend.

3. PROBLEM IN SETTING THE WEBSITE

We also wanted to know what the problems are that the firms faced in setting up their website. One of the major factors holding the firms back is that maintaining a website required too much time. For a website to be useful it has to be updated periodically and this naturally requires manpower and man-hours. As the benefits of a beside are still not very clear to the firms, we believe the firms would be reluctant to invest in setting up a website.



Graph D : Problems Faced In Establishing Website

This reasoning is also indicated in the survey data where 29% of the respondent comments that high cost is a deterrent factor. In addition to the above, 11% of the respondent also mentioned security as a problem in having a website. More than 15% of the respondent did not mention a specific problem. We assume that this 15% could be due to a lack of existing info-structure and infrastructure in the firms.

The nature of the construction industry is different to other industries, such as the manufacturing or retail sector, where processes and the working environment are well defined and controlled.

Below figure A shows the temporary nature and uniqueness of construction projects is reflected in one-off locations, one-off designs solutions and one-off project teams, which leads to a very fragmented communication platform. This has lead to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains.

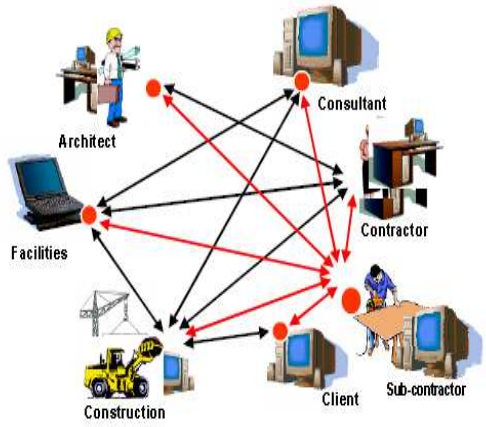


Figure A : Fragmented nature of the Construction Industry

Above figure B shows this, in turn, has created challenges for the application of ICTs in the Irish construction industry. It is now becoming accepted that the preferred communication model for managing information on a construction project should be based on a central project model, through which, all the information is disseminated. A common tool used is a project extranet.

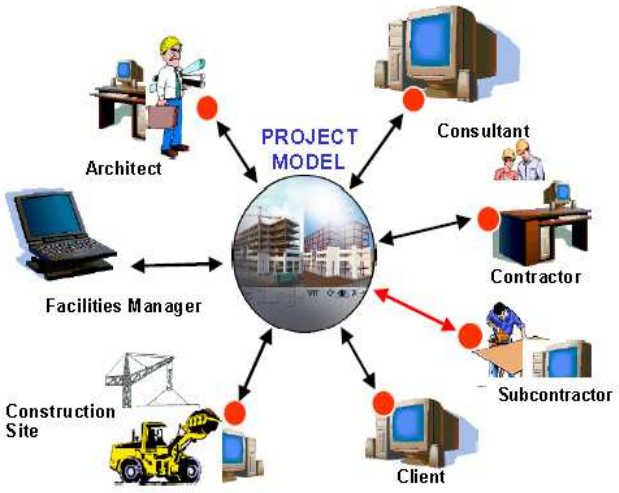


Figure B: Prefferec Communication model for Construction.

V. COMPUTER AIDED DESIGN ANDVISUALISATION

Computer Aided Design (CAD) software is widely used by design professionals, with AutoCAD having the largest share of the CAD market. Other popular CAD packages include Microstation, ArchiCAD, MiniCAD, FastCAD, etc. These CAD programmes have replaced the traditional drawing board in the production of design information. 2D CAD systems have dramatically improved the drawing process. 3D modelling can enable designers to investigate the buildings internal spatial system and its relationship with the surrounding environment. Visualisation and animation systems, like 3D Studio, Graphisoft, Revitt and ArchiCAD, can produce photo-realistic, static and moving images so that clients can view the final appearance of the building at the design stage. Virtual Reality (VR) technically now allows the user to integrate with the design model and experience the building in simulated reality situations.

Building Information Modelling (BIM) is an innovative new approach to building, design, construction and management. BIM keeps critical design information in digital forms making it easier to update and share design information. It also creates real-time, consistent relationships between digital design data with the use of innovative parametric modelling technology techniques. Autodesk Architectural Desktop and Autodesk Building Systems are examples of software currently available.

1. BUILDING ENGINEERING APPLICATIONS

Over the past two decades, a range of building engineering applications have been developed for energy analysis, HVAC design, structural analysis, lighting simulation, etc. The benefits of these applications are that they allow designers to evaluate alternative design solutions in order to achieve the optimum design. They also help to ensure that the design complies with building regulations. Software packages such as CADLink from Cymap and the HEVA Comp package both offer a comprehensive range of software options for energy, lighting and building services design.

2. COMPUTER AIDED ESTABLISHING

Controlling costs is one of the most important requirements during a construction project. To achieve this, contractors and subcontractors must first produce an accurate cost estimate to establish the tender price. Today, there are sophisticated computer software packages such as Esti-mate, Manifest, which allow project managers to assist in the production of project estimates and keep track of project spending.

Many of these programmes can assist in the quantity take-off in the production of bills of quantities. Examples of such software includes, Buildsoft, Masterbill, CATOPro etc. Modern cost estimation programs can be integrated with CAD programs and linked data for labour, materials and plant. The advantage is that cost data does not need to be re-entered thus improving the speed of estimating and avoiding errors.

3. PLANNING SCHEDULING AND SITE MANAGEMENT

It is a common misconception that computers are of little help on a building site. In fact computer systems can assist site personnel to plan, co-ordinate and generally to become more efficient in the administration of the project. Apart from the widespread use of planning packages such as, Pow-

er Project and Microsoft Project, there are solutions from Primavera, COINS and the growing interest in web-based collaboration tools.

An additional area that is rapidly expanding is in the use of mobile technology. Mobile technologies enable physical separate hardware devices to connect and share data. Developments in this technology have led to the amalgamation of mobile computing devices and mobile communications protocols, with Personal Digitised Assistants (PDAs) now available with integrated mobile connectivity or via a separate mobile phone, through either a wired or wireless connection such as Bluetooth. This provides the mobile user with the ability to upload and download data from anywhere that a mobile signal is provided. An example of an recent initiative in the UK focusing on mobile computing is construction is the 'Construction Opportunities for Mobile IT' (COMIT).

4. COMPUTER AIDED FACILITIES MANAGEMENT

Facilities Management (FM) is a relatively new phenomenon which emerged in the early 1980's. It reflects the wide recognition of the importance of building operations and maintenance and the impact they have on the life cycle cost of a building. The software available for FM has developed from a combination of CAD and database management systems. CAD is often used to provide data on departments and location of individuals, together with their services. Special routines enable blocking and stacking studies to be carried out to explore alternative layouts or to reflect on organisational change. The database is the most important part of FM software as it holds data on people and their services.

VI. DEVELOPMENT OF IT TRAINING OF CONSTRUCTION INDUSTRY

Assessing the economic impacts of IT investment has become one of the major issues in contemporary management. Information technology has its origins in the technologies related to a restricted view of information: the generation, processing and distribution of representations of information. Examples are telecommunication and computer engineering, the data processing and office machinery industries. However, the cost of information is attributed to two main components: the intellectual labor involved in originating and handling it, and the non-human element made up by processing and storage equipment, distribution media, etc. Information technology means the collection, storage, processing, dissemination, and use of information. It is not confined to hardware and software, but acknowledges the importance of man and the goals he sets for this technology, the values employed in making these choices, and the assessment criteria used to decide whether he is controlling the technology and is being enriched by it.

IT infrastructure is a shared facility. Thus, IT not only involves the scientific, technological and engineering disciplines, but also the management techniques used in information handling and processing; their applications; and their interaction with men and machines; and associated social, economic and cultural matters. Advanced automated process technologies are conducive to a certain degree of team autonomy. The choice of a particular technology is itself the outcome of socially constructed decisions and the reflection of particular social values. The risks in IT applications is not rather the issues of IT itself than that of social, cultural, political and economic. The technology can be regarded as having an independent influence on issues such as skills, supervision and work organization.

IT is not only used to rationalize routine business processes in the corporate office, but involves using technology in ways new to the organization to achieve process innovations. The main thrust of IT is not only to improve efficiency through cost savings and cost displacements, but to improve effectiveness, to gain and sustain competitive advantage and to transform entire business processes. For instance, the demand for office space has been reduced with the emergence of IT.

Many clients are convinced that using IT-oriented management does improve corporate images. Thus, the benefits from IT are difficult to measure and often hidden and cumulative. There are doubts whether the return from IT is being properly measured. The traditional measure in business for investment in capital equipment is return on investment. For IT, this should be a complex measure, which includes quantifiable improvements in performance as well as an assessment of new business opportunities, risks and uncertainties arising out of the investment.

1.IT SHOULD BE LINKED TO CORPORATE STRATEGY

An IT strategy is concerned with the planning, introduction and use of IT resources, for the benefit of the entire organization. The strategy itself must be closely linked to the strategies for other aspects of the organization. The treatment of organizational and managerial issues is perceived as more important than technical issues in determining the successful application of IT in office. For instance, there are strong cultural barriers that still need to be broken down before IT becomes more widely adopted. One of the major barriers is lack of understanding of IT potential by senior management. In particular, those employees coming from larger organizations are likely to perceive organizational issues to be of more importance than technical issues. It is thus argued that organizations should direct their strategies towards building and maintaining an information infrastructure. The information infrastructure is a social construction, as it covers all IT elements that are to be shared by organizational agreement. With these views of information technology in mind, investments in training in various fields of human endeavor in order to fit for the IT environment is extremely important. Thus, IT spending should include the cost of hardware, software, consultancy/ outsourcing and standard training.

It is expected that information technology in an office can increase efficiency and productivity through.

(a) better use of company resources by automating the routine functions;
(b) better communication to facilitate decision making;
(c) increased ability to make sound decisions involving complex combinations of factors;
(d) effcient use of time by making facilities available for longer working hours; and
(e) allows for on office decentralization so as to reduce rental costs.

However, the use of IT is often not aimed at automation. In offices where the new electronic equipment has been introduced, people had to get used to new machines and new work patterns. The cost-effective use of information tech-

nology requires the rethinking of the entire pattern of flow of information within the office and the re-training of staff. This, in turn, is likely to demand organizational changes whose effects are bound to be even more far-reaching than the piece-meal introduction of the personal computers.

VII. USE OF IT IN CONSTRUCITON INDUSTRY

The construction industry is becoming more complex in nature with the introduction of advanced technology and complex building design. Division of labor is important in the industry. Architects are responsible for the design, preparing sketch plans and setting cost limits. Quantity surveyors are responsible for the cost planning and controls of the projects. Quantity surveyors use computers to assist their work to prepare Bills of Quantity. Construction engineers are responsible for the design of civil works and structure loading. Construction cost management is implemented across all project stages including feasibility study, design, construction and operation.

For example, the Automated Cost Estimating Integrated Tools (ACEIT) has been widely used for estimating construction cost. The applications of IT in engineering design include Computer-Aided Drafting; Computer-Aided Tool Design; Group Technology and Computer-Aided Design (CAD). The application of CAD is a typical example in effectively using IT in construction. The main benefits of CAD seen by professionals are the improved accuracy and legibility of engineering drawings and the ease of making alterations to designs, leading to consistent quality; a better capability for the coordination of complex operations; the possibility of examining various alternatives at reasonable cost; and thereby improved designer productivity.

One difficulty in performance measurement is that IT gradually accrues to a construction organization as a whole, and are not always visible as improvements in the short term performance of individual construction operations. It is often difficult for a construction company to justify expenditure that cannot be related to specific projects or construction processes and which will not produce benefits until sometime in the future. To deal with this problem, it may be necessary to include dimensions representing long-term profitability of the company. While the vast majority of construction enterprises use IT as a support activity, some construction sector organizations make IT a critical part of their strategic development plans. Many of the available IT tools have been developed without due regard to the total construction process. The most important issue in the implementation of IT, which distinguishes construction from other sectors, will be the integration problem: that is, how to exchange information among different designers and also between designers, clients and contractors. The whole construction project process involves great deal of information handling through all project stages such as feasibility study, design, tendering, building and operation. A number of Indian firms contracting firms are exploiting the full range of IT including data processing, telecommunications and automation technologies.

In the IT environment of QS and architectural firms, the PC appears to be the major assets. The impact of IT on organizational productivity may be different between small and large companies. However, most architectural firms are of small size, thus the strategic exploitation of IT in this industry has been much less successful. The main advantage of IT utilization in such firms is technical enhancement, rather than re-engineering of organizational functions and operations. However, QS firms have more fully embraced the PC, and are in a situation of having a range of hardware and software technologies being used by a diverse range of groups of people and for a variety of different tasks and activities.

2. CURRENT USE OF IT IN LEADING CONSTRUCTION INDUSTRY

In addition to the general survey, an in-depth with a leading firm in each of the professions under study. For confidentiality, the names of the firms were kept anonymous. However, all the firms claimed that as far as IT development and applications were concerned, they were all leading the profession. They have involved substantially in public and private construction projects. This in-depth interview provides indications as to the high-end of IT applications in Indian construction industry. The uses of IT applications vary in the three professions. The QS firm mainly uses IT applications to estimate building costs, prepare tender documents, monthly valuations and final account of building works. Apart from word processing and spreadsheets applications, the QS firm also deploys some self developed packages (by its overseas counterparts) to conduct site formation and cash flow analysis. For security reason, designated staff via different PCs networked by Novell, Unix and NT have access to different level of databases in which cost data and tender documents are stored. At the back-end, a HP Net LM machine is the major server.

The architectural firm mainly uses IT packages for architectural design, technical drawings and model simulation. Major software deployed including AutoCAD, Photoshop, 3D Studio and Microstation. Network infrastructure is basically a Unix one supported by a Sun Sparc machine, and a few PCs run on an NT server. All the construction firms has connected to the Internet and subscribed to a lease line, even though some of them have established their own Intranet system. The modems are being used to connect to the Internet and receive e-mails. In summary, the construction firms believe that the use of IT can increase their productivity. Although the extent to which the increase in productivity may vary across professions, the main reasons for employing IT are set out as below:

2.1 Contributing to Core Business

As the accountant of building works, a prudent quality assurance process is of paramount importance for a QS firm to value building costs. An erroneous input or calculation in an account may nullify all the efforts put into the whole task and is extremely difficult to remedy. Hence, it is essential for a QS firm to use standardized software so that a reliable quality assurance process can be developed. In this sense, IT applications contribute directly to QS firm's core business effectively. IT applications in engineering and architectural firm are relatively more peripheral. In India, most construction engineering firms actually engage in construction design (consultancy). These applications can streamline the tasks tackled by the engineers and architects, such as the technical drawings. However, the value added of IT to the engineering consultants and architectural firms are much less than that to the QS firm. As a matter of fact, both the engineering firm

and architect firm admitted that some of their tasks have gone IT simply because of client's requirement, such as the prevalent submission of electronic format technical drawings by government bodies for environmental concerns. Generally, the public sector is both a major user of construction resources and a major determinant of the context for private demand and the environment in which the industry works. Hence, there is a need for the firms to review public policies in the light of likely future needs for construction work.

2.2 Cost Effectiveness

Cost effectiveness is measured by the ratio between the additional return to additional investment. Due to the simple job nature of the QS firm, the IT applications used by the QS firm appear to be more cost effective than the engineering consultants and architectural firms. For instance, the QS firm indicated that they use a low-cost computer package (such as a spreadsheet program) for estimating building cost. The only required hardware is PCs of 486 grade or above. In contrast, an architectural firm would have to invest hundreds of thousands of US dollar on high-end products like Silicon Graphics, that can be used to present a sophisticated 3D simulation model or some virtue reality materials to its client. However, the architectural firm may find it more cost effective to contract out such advanced tasks to another related specialist.

2.3 Company Policy and Attitude

It is the QS firm's policy to make all newly recruited and managerial staff proficient in its cost-estimation software. For instance, they provide a series of training and workshops. In comparison, in the engineering consultants firm, only the managerial staff who involves in building projects are required to be proficient in the IT applications. However, there is no specific requirement for the managerial staff of architectural firm in the use of IT.

It was indicated that staff who want to develop their career in the company would have to get familiar with the IT applications. It seems that the opportunity cost of not using IT application in the QS firms is much greater than that in the architecture firm, since IT knowledge becomes a basic requirement for the former. It should be noted that owing to the job nature of architectural firms, the switching costs in using IT packages are enormous for most architects. To advance the future development and sustain market leadership, the firms indicated that they have already stipulated their IT development plan in the following two years. Although all the firms admitted that the use of IT applications can help increase productivity, there are concerns about non-measurable cost of supervision if communication is too “easy" among the staff. However, all the firms indicated that some suitable office management applications may be employed to help facilitate the flow of working materials within the firm and among their business partners.

A contractor can benefit from the Intranet as the contractor can use Intranet to connect the head office to a few site offices. Furthermore, the Extranet can be employed to form a cooperative network environment, allowing exchange and storage of information among the project team members; i.e., the main contractor, the client, the engineers, and the project manager. However, the nature of site processes, the structure and procurement methods of the industry, the craft nature of the tasks on site, and the education processes of all personnel reduce the capability of the construction industry to harness the power of the computer to improve its performance. To exploit the economic advantages of IT, systematic planning and staff training are required to achieve widespread application of IT in construction.

VIII CONCLUSION

Indian construction industry has the latest in hardware and software, but does not have adequate and trained personnel to utilize the same. It can be summarized that IT is used mostly in administration and other supporting area, but not in strategic core and business enhancement processes. Technical and project use of IT is increasing and the benefits are recognized by the companies. If above areas of IT applications are strengthened the Indian construction industry will reap greater benefits. Use of IT is prevalent at lower level, however top management of construction organisations should have strong commitment to develop strategic management of IT in their business processes at all level. The hardware, software and their applications should be utilized to enhance both core and supporting activities to gain competitive advantage in today highly global business environment. The firm's management should give greater attention to IT support and training, by making sure that there is sufficient trained staff for the implementation of IT, and making greater effort in training staff on the correct and efficient use of IT in the organization. Organizations of construction firms are in many ways more diverse and complex in their range and interrelationships. For example, the architect, engineers, builders, client and surveyors share and exchange information and data which evolves as design progresses. Engineers, architects and quantity surveyors are facing a realignment of traditional practices and redistribution of responsibilities with the continued development of information technology; those who adapt will be able to reap benefits in productivity, resulting in greater competitiveness in the construction industry.

REFERENCES

[1] Amorous, DL, C Springs and PH Cheney (1992). Quality end user-developed application: some essential ingredients. Database, Winter, 1{11}.

[2] Belcher, LW and HJ Watson (1993). Assessing the value of Conoco's EIS. MIS Quarterly, 17, 239{253}.

[3] Ballantine, J and S Stray (1999). Information systems and other capital investment: evaluation practice compared, Logistics Information Management, 12(1/2), 78{93}.

[4] Betts, M (1992). How strategic is our use of Information Technology in the construction sector? The International Journal of Construction Information Technology, 1(1), 79{97}.

[5] Betts, M, K Mathur, G Ofori and C Lim (1991). The strategic use of information technology in the Construction Sector. In Applications of Information Technology in Construction, Maxwell, JWS (ed.), England: Thomas Telford Ltd.

[6] Brandon, PS and RG Moore (1983). Microcomputers in Building Appraisal. Granada Publishing. Brandon, P (2000). Construction IT: Forward and To What? Implementing IT to Obtain a Competitive Advantage in the 21st Century. H Li, QP Shen, D Scott and PED Love (eds.), pp. 1{15. Hong Kong Polytechnic University.

[7] Bussen, W and MD Myers (1997). Executive information system failure: a New Zealand case study. Journal of Information Technology.