OPPORTUNITIES FOR IT IN CONSTRUCTION INDUSTRY OF IRAN

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Abstract

The last twenty-five years have seen dramatic improvements in and widespread use of IT to describe and document the work of the many disciplines involved in construction projects. Iran is a developing country and construction is a basic factor of developing too. Hence, the country needs to a special programming for construction of buildings, structures and infrastructures. Many parts of Iran are located in highly seismic zones and structures must be constructed safe e.g., according to recent seismic codes. In this paper opportunities of IT in construction industry of Iran are investigated in three categories. Pre-construction phase, construction phase and earthquake disaster mitigation are studied. Studies show that information technology can be used in these items for reducing the losses and increasing the benefits. Both government and private sectors must contribute to this strategic project for obtaining the best result.

Keywords: approval, building, construction, document, earthquake, industry, IT.

1. Introduction

Construction industry is undergoing significant changes, mostly driven by the ongoing information technology revolution. In the past, the use computers in this industry was limited mostly to the detailed design stage including analysis, dimensioning and numerical optimization of structural systems [1]. During the last 20-25 years, significant progress can be observed in design science, in computer science and in computer engineering. Successful application of IT in other industries causes the opportunity for construction industry to use the benefits of IT. Iran as a developing country, attempts to apply this modern technology too. IT can be used in pre-construction phase, construction phase and service phase for obtaining the most performances and the less losses.

2. Pre-construction phase

The amount of time required to prepare a basic home floor plan varies depending on the size and scale of the homebuilder. Builders want to reuse their base plans, but they must always be modified to meet legal requirements, environmental conditions, local ordinances and customer preferences. In many cases the magnitude of change requires so many changes that each home is essentially unique.

While the time needed to modify plans varies with the size of the design firms, there was agreement that these changes can be made more quickly than the necessary approvals can be obtained. This is especially true at the local level. It was agreed that the cost of design is small relative to the cost of the delays associated with getting new approvals. Based on the potential speed with which initial design and revisions can be made, and the fact permitting takes much longer, it was felt that new IT innovations to accelerate the design process are less important than using IT to improve the pre-construction approval process.

Many types of code and regulatory approvals must be obtained from different jurisdictions before a home can be built. These requirements originate from all levels of government including province, city and town, as well as local zoning restrictions. The discussion was generally organized into three categories: land development approval, permitting (e.g., building codes), local planning and zoning requirements (e.g., appearance and style guidelines). Regardless of the level of jurisdictional approval, it was generally agreed that the approval process could be delayed by a negative synergy. At the same time requirements are often poorly known and change with time. In some cases requirements change while plans are passing through the approval processes [2].

This means that when plans emerge from one part of the approval process, they may fail another due to new rules that were not initially required. This cycle of inefficiencies can potentially be repeated when a builder resubmit revised plans. The extended delays can become costly to builders who must pay interest on loans for large tracts of land while plans are redesigned and approval is sought. In some cases, this can result in large financial losses and even the cancellation of the development.

Given these sources of cost and delay and the prospects for an increasing labor shortage, it was recognized that the home building process might need to change in future. It was also recognized that the use of IT in other sectors of the economy has begun to change traditional business models while improving quality, lowering costs and increasing the speed at which products are brought to market.

There are many opportunities for IT use ranging from email to automated code checking and paperless offices. While the housing industry is generally slow to innovate and embrace technological change some private sector firms are already beginning to capture the benefits of IT. From the adoption of electronic mail, to bringing laptops into the field, to integrating design and manufacturing processes, the varying degree of IT usage is to be expected given the number and diversity of private sector firms and the hard to quantify benefits some investments will yield. It was agreed that IT tends to strengthen communication within the firm and between suppliers and customers. This improved communication was believed to result in improved products and lower cost.

While email may be perceived as the most common form of Internet communication, it is only a small portion of what IT can offer. The true benefit of IT comes from the integration of information and control that a network can offer. For the private sector, one of the most common uses of is to link key individuals and systems so that all phases from design to production can be coordinated and optimized. Such systems could even be designed to allow suppliers and customers to see when the next shipment of raw materials are needed or when finished products are scheduled for delivery.

Just as firms can benefit from internal networks, so too can the builders, architects, material suppliers, trade crews and inspectors that depend on each other to bring a project to completion. From designing blueprints to ordering materials to scheduling mechanical and electrical crews, these parties need to coordinate their activities with each other, and their schedules can change frequently depending on plan revision, inspections, inclement weather, etc.

Accordingly, a number of dot-com companies have been founded to try and improve communication and cooperation among these diverse and fragmented parties. Most of these firms are developing Internet websites that utilize a client-server model where the dot-com company hosts project documents and schedules on their web site so that all parties can access up-to-date information and even revise that information asynchronously or concurrently from one or more locations.

As with the private sector, IT could be used within the public sector to reduce or remove many sources of cost and delay. Opportunities ranged from posting codes and special documents on the web, accepting plans electronically, automated code checking, developing virtual or remote inspection technologies and a public information portal.

2.1 Posting of codes on Internet

Designers, builders, inspectors and suppliers would benefit if all regions, towns, cities and provinces were to put their codes and regulations on the Internet. This would allow governments to update them instantly while allowing firms real-time access to the most recent information available. And as wireless technologies improve, this information would even be available in the field. This would reduce the time for inspection as well as the number of times plans had to be sent back to the builder to correct problems. The result would be fewer delays for builders, reduced time for plan checking and lower costs to consumers.

2.2 Electronic process of plans and permits

If builders could submit plans and permits electronically, that would eliminate delays associated with physically mailing or carrying plans from location to location. Enhanced distribution using IT would make it easier for building departments to work with other province, city and town agencies to work together efficiently. It must be noted that the new

Internet-based application service providers may represent the first step in transitioning from paper-based offices to digital paperless offices.

2.3 Automated plan checking

The approval process could be radically accelerated if plans automatically inspected by computer programs. The time saving would benefit builders, consumers and the government. It could even be possible for code checking software to grade plans, identify what needed to be changed and provide a link to the relevant code. Furthermore, designers could use the code-checking program prior to government submittal thereby reducing or eliminating problems all together.

2.4 Site inspection

There are new technologies for remote or virtual inspection. For example, remote stationary cameras can allow constant monitoring while mobile cameras with high-speed Internet connections can be moved around a site under the direction of an inspector seated at their desk at the building department. While these technologies are possible today, some questioned whether remote or virtual inspections could truly substitute for an inspector walking the site to ensure that it is safe for workers and meeting code requirements. Conversely, a mobile camera system could be used to remotely follow-up on problem areas identified during earlier on-site inspections.

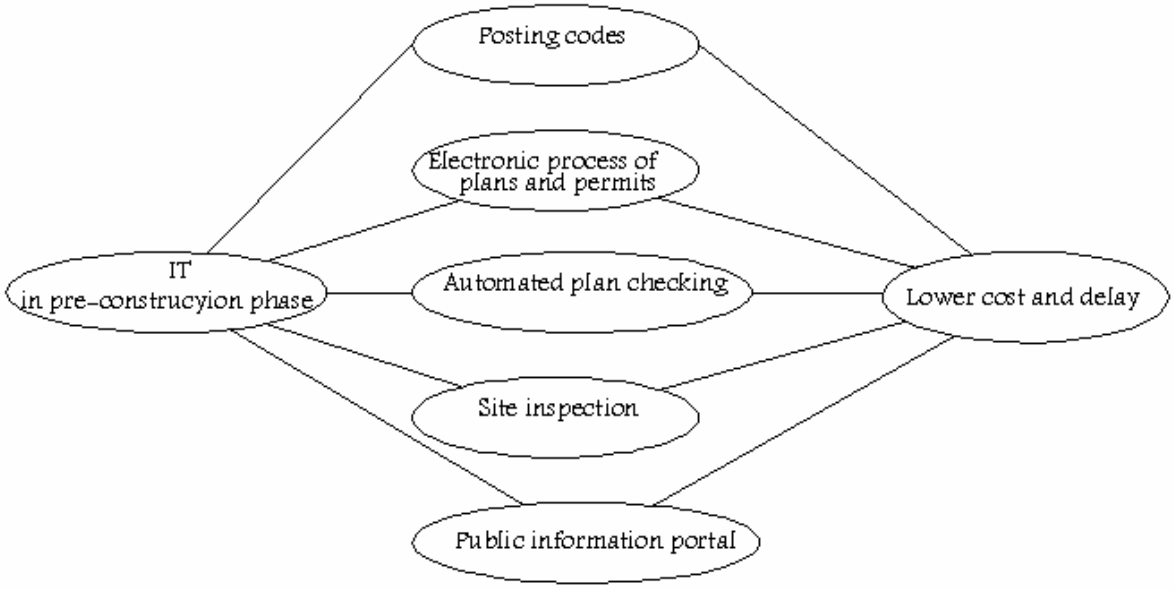
2.5 Public information portal

It was noted that private sector websites hold great potential for educating designers, builders and customers about new products and processes. But it was also noted that those websites would generally be oriented toward selling products rather then on broader issues and objective information. This led to establishing government-supported information portals to share information without commercial influences or advertisements. Also, municipalities and other related part of the government must manage some websites for educating the people against the hazards of earthquake. The recent earthquakes and their casualties and losses must be shown in these websites. Public awareness must be upgraded through the IT for reducing the future losses. Moreover, the paying method must be changed from the current manner to electronic paying through the Internet and debit cards. Figure 1 shows the role of IT in pre-construction phase.

3. Construction phase

All project information is entered into software tools or generated by computer programs and is represented in the many different formats used by many disciplines involved in a project. For most decisions about a project, engineers from different disciplines (designer, project

manager, cost estimator, scheduler and mechanical, electrical and piping coordinator) need to share their information with others on the project team. In such meetings, each engineer formed an image of the current status of the project and visions of future situations in his/her head based on his/her own interpretations of the documents from the other engineers. These interpretations formed the basis for discussions and decisions about the most appropriate design of the facility and its part, when, how and by whom it should be built, how long the whole project or a part of the project should take, how much things will cost and etc [3].



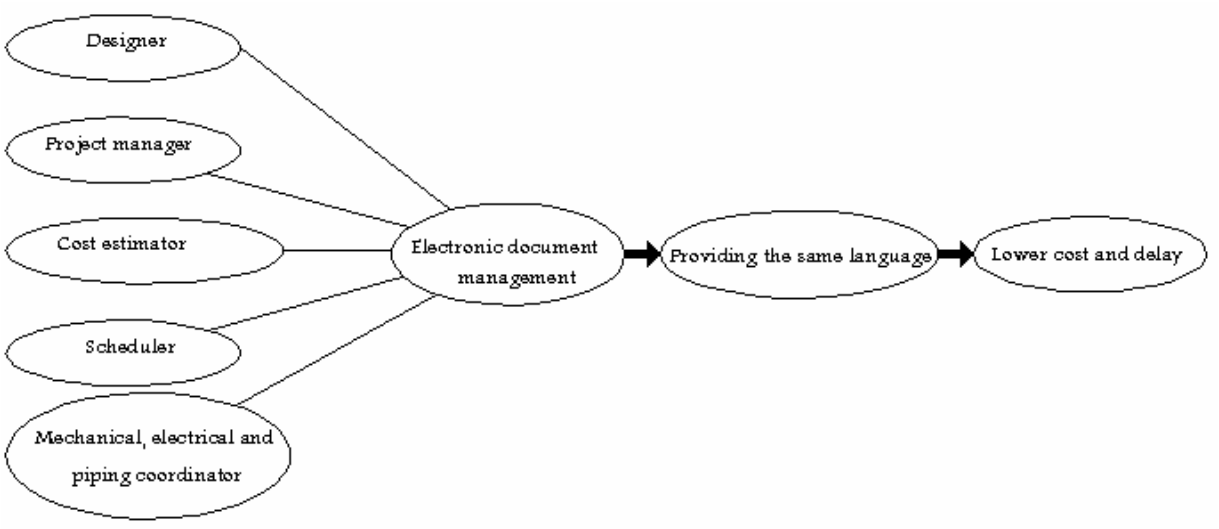
"Figure 1: Role of IT in pre-construction phase"

Documents are the central mechanism for managing, communicating and contracting in an engineering environment, in particular when considering it within the construction industry which is made up virtual companies formed for a short duration when compared to the life of the product. Manufacturing industries are more commonly formed of long established organizations producing relatively short life products, in contrast with the expected life of many buildings.

However, their approach to documentation and its purpose is more sophisticated and better supported by IT than the generally adopted by the construction industry. Such IT support that is available has been developed independently leading to company or project stand alone product, process and document management systems, lacking the capability for the immediate integration essential when quickly forming new temporary organizations [4].

An electronic document management system will have to provide tangible benefits over the traditional paper system. Speed is an obvious advantage, saving resource costs and storage space, but the industry will need to overcome its habit of waiting for an official paper version before committing itself to an action.

Figure 2 shows the role of IT in construction phase. As shown in this figure, the application of information technology in different parts of the construction industry generates a more suitable and economic industry.



"Figure 2: Role of IT in construction phase"

4. Earthquake disaster mitigation

Iran has witnessed many earthquakes during past 50 years causing many casualties and immense property loss. More than 85% of these casualties are due to collapse of buildings and they occurred within very short period of time after the earthquake. For studying the response of the structures and consequent issues after the earthquake disaster, IT can play a major role.

According to the 3rd edition of Iranian code of practice for seismic resistant design of buildings (e.g., standard no. 2800) more than 75% of Iran is prone to earthquake. Metropolitan cities like Tehran and Tabriz lie in zone 4 and Mashhad, Shiraz, Rasht, Kermanshah and etc., lie in zone 3. In these cities and other parts of country, seismic response of existing structures should be studied and proper retrofitting should be carried out in order to reduce the casualty and property losses [5]. Hence, there is a need to for a disaster mitigation system. It is clear that many casualties occur within very short period of time i.e., within few minutes after the earthquake has occurred. This means, most of the problems after the event are generated mainly because of failure of structures. Earthquake disaster reduction broadly consists of three components, including mitigation, preparedness and reconstruction [6].

4.1 Mitigation

Damaging effects of earthquake can be mitigated by controlling the vibration of tall structures and very important structures and facilities, strengthening and rehabilitation of existing structures and building safe structures in seismic zones. Active control of vibration in structures has been investigated by an increasing number of researchers in recent years. Underlying concept of this method is that waves take some time to travel inside the structure. In the meantime seismometers monitor the response of the structure by performing nonlinear analysis and they estimate the lateral forces likely to be generated in the building. Then immediately signals are sent to the actuators located at different floors to apply suitable

damping. For studying this, there has been a great deal of theoretical work and some experimental has done, examining the use of point forces for vibration control, and more recently, the use of thin piezoelectric crystals laminated to the surface of structures [7].

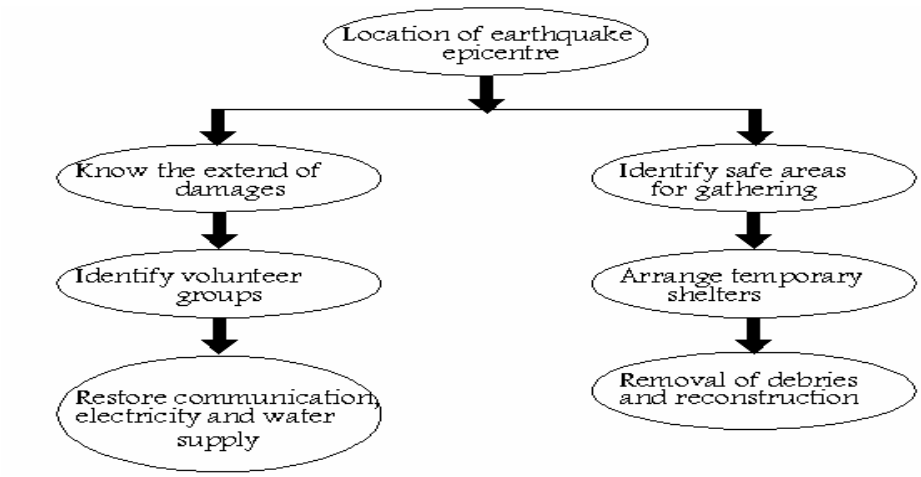
As a countermeasure for reducing the loss due to upcoming earthquake events, upgrade of the seismic performance of existing structures is most urgent issue in highly seismic regions. This involves economic and social aspects. Adoption of preventive strategies will go long way in reducing not only the suffering of the people but also the economic losses and calamity relief costs in the long run. Post-construction strengthening of structures for upgrading seismic resistance is more involved and costlier than ensuring adequate resistance at the time of initial construction. Hence, there is a need to develop some technique to assess the strength of the existing weak structures and suggest a suitable retrofitting method.

4.2 Preparedness

There is a general lack of understanding about the occurrence of earthquake hazards, the underlying scientific phenomena, the extent and type of possible effects, the methods and effectiveness of protective methods and the cost of protection. Not only lack of understanding, but even misunderstanding and wrong beliefs also exist in the society. A concerted effort needs to be made in a well-planned structured way to address the target audiences [8,9].

4.2 Recovery and reconstruction

Immediately after the earthquake the primary concern is to know the extent of damage and how much area is affected. Figure 3 shows the process of recovery and reconstruction after an earthquake.



"Figure 3: The process of recovery and reconstruction"

Aerial photography and GIS must be used for achieving these goals. The assessment and demarcation of earthquake-affected area can be done through quick aerial photography after an earthquake. Classification of damaged areas into worst; moderate and least affected areas

can be done through the use of different color tones on the satellite imageries and aerial photographs.

5. Conclusions

The shortage of financial resources and absence of strong will for change are recognized as making innovation such as IT, unlikely to happen at the local government level such as municipalities, without additional specific support and assistance. The benefits of IT (designing and buildings the structures more efficiently and at lower cost) must be demonstrated for people. Such demonstrations would help show the value of IT to builders who would then be more likely to make such investments on their own.
Management of documents provides information about all aspects of project. It is clear that, through careful management, documents can provide the means to co-ordinate work on the activities required to complete a project and to determine how processes can be managed to greatest effect using concurrent engineering frameworks.
It is necessary to understand the performance and behavior of the structures during the earthquake and consequences arising after structures damage. IT can be used as a tool for educating people and minimizing the losses of earthquake. Also, public learning and educating must be organized through the Internet and websites.

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References

[1] **Kicinger, R. and Arciszewski, T. and Jong, K.D. (2003).** "Conceptual design in structural engineering an evolutionary computation approach". Proc. of the 2nd international specialty conference on the conceptual approach to structural design, 529-536.
[2] **Hassell, S. and Bernstein, M. and Bower A. (2000).** "The role of information technology in housing design and construction". Science and technology policy institute, 1-35.
[3] **Mokhtar, A. and Bedrad, C. (1994).** "Towards integrated construction technical documents-a new approach through product modeling". proc. of the first European conference on product and process modeling in building industry, 3-10.
[4] **Finch, E.F. and Flangan, R. and Marsh L.E. (1996).** "Electronic document management in construction using auto-ID". *J. of Automation in Construction*, 5, 313-321.
[5] **Building and Housing Research Center. (2005).** "Iranian code for seismic resistant design of buildings", 5-15.
[6] **Ramancharla, P.K. (2002).** "Role of information technology in earthquake disaster mitigation". Earthquake engineering research center, 1-9.

[7] **Andrew J. Y. (1995).** "Active control of vibration in stiffened structures", School of mechanical engineering, The university of Adelaide, Australia, PhD dissertation.
[8] **Sawhney, A. and Mund, A.** (1998). "Simulation based construction management learning system". Proc. of the winter simulation conference, 1319-1324.
[9] **Echeverry, D. (1996).** "Multimedia-based instruction of building construction". Proc. of the third congress on computing in civil engineering, 927-977.