Sustainable Development in Construction

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Abstract—Semnan is a city in semnan province, northern Iran with a population estimated at 119,778 inhabitants. It is the provincial capital of semnan province. Iran is a developing country and construction is a basic factor of developing too. Hence, Semnan city needs to a special programming for construction of buildings, structures and infrastructures. Semnan municipality tries to begin this program. In addition to, city has some historical monuments which can be interesting for tourists. Hence, Semnan inhabitants can benefit from tourist industry. Optimization of Energy in construction industry is another activity of this municipality and the inhabitants who execute these regulations receive some discounts. Many parts of Iran such as semnan 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, industry, IT, Semnan

I. INTRODUCTION ABOUT SEMNAN

SEMNAN is a city in semnan province, northern Iran with a population estimated at 120,000 inhabitants (2005). It is the provincial capital of semnan province.

Semnan is situated at 1,138 metres above sea level at the southern foot of the Elburse Mountains.It is the regional market for local grains and cotton. The production of textiles and carpets are the most important industries in the history of city. but nowadays in compare with its population Semnan have very powerful industrial specially in the field of Automotive (Cars and Bikes). Semnan has traditionally been an important stopover on the trade routes between Tehran(220 kilometers [136 miles]) and Mashhad (685 kilometers [426 miles]), and is today linked with the two cities by road and railways[1]. To the west of the city is "Maleh" which used to be a separate settlement but was not a part of Semnan. In the local language the inhabitants are known as Malezh. "Maleh" is consist of three part Kuery (Kodivar), Kushmaqaan, Zavaqaan. Nowadays "Maleh" is part of Semnan. Figure 1 shows the map of Semnan.

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The mountainous region of the province experiences a cold climate, whereas the mountain skirts and around the fringes of the desert is temperate and warm respectively. The city of Semnan experiences warm summers and moderate winters.

Fig. 1 The map of Semnan

Semnan province can be said to be divided into sixteen sectors from the olden days dating to the time of Avesta. During the Medes and Achaemenian periods, it accounted for being as one of the largest provinces of the Parthians. Likewise, this region held its importance during the Sassanide period, and thence in the post Islamic era was part of the historical region of Gomess or 'Komesh'. Needless to say, this province was witness to wars, defeats and victories in the past. The 'Silk Road' paved its way from the midst of this region [2].

Besides which a number of historical relics such as, palaces, buildings, castles, ancient inns or 'caravansaries', water reservoirs, towers, rampart and… have created an imprint here. To state a few examples such as, the palaces of Aqa Mohammad Khan and Fathali Shah in Damqan, the palaces of Shah Abbas, Einol Rashid and the Haramsara or special apartments for the women (of the palace) of Soltani in Garmsar. Edifices belonging to the daughters of Naseredin Shah in Damqan, the castles of Saroo, Kushmoqan and Pachenar in Semnan, the castles of Lasjerd and Benkooh in Garmsar and ... are interesting historical relics of the province.

In addition to the above, there are various religious and sacred places and mosques such as, the Soltani Mosque, the Jame' Mosque, the Tarikhaneh Mosque of Damqan, the Jame' Mosque of Bastam and ... are such examples.

Moreover, the province encompasses various cultural traditions and rituals. These can be related to national or religious festivities, marriage ceremonies and both public and private mourning ceremonies including religious rituals, which hold their own and differ from other parts. This province can boast of scholars and poets such as, Manoochehri Damqani, Ebne-Yameen Forumadi, Forouqi Bastami, Yaqma'ie Jandaqi, and Zowqi Bastami. Regarding scholars and Gnostics of this region, such personalities can be named as; Bayazid Bastami, Sheikh Abol Hassan Kherqani, Sheikh Allaoddoleh Semnani, Sheikh Sakak and Bibi Manjomeh Semnani are worth mentioning.

As to the reputed contemporary personalities, Haj Ali Semnani, Feyz Semnani, Zabiollah Safa and Ali Mo'alem can be quoted as examples. One of the outstanding rituals of the region is the refraining from wearing black clothing during mourning ceremonies, thus revealing a basic revulsion towards the 'black flag' of the Abbasian dynasty.

Arq is a relic from the reign of Naseredin Shah Qajar. The upper structure of the southern gateway is in two storeys, with chambers on two sides of the corridor on both floors. The said gate-way is located at the cross-roads of Ayatollah Talleqani Ave., and Sheikh Fazlollah Noori Ave., of Semnan. This was constructed during the reign of Naseredin Shah, in the years 1300-1305 AH. The gate-way has been made of brick and stands to an elevation of over 7 m. The ceiling of the chambers resembles a barrel, but the main rooms have ceilings covered with shallow domes. The master-piece of this structure is the door way, worked with pieces of seven-colored tiles depicting a scene from the myth of Rostam and the white monster. (Figure 2)

Fig. 2 Arq gate-way

Jame' mosque was constructed in the 1st century AH. On the site of the ruins of an ancient fire-temple. Evidences can be noted here from the Mongol and Teimoorid periods. Its tall brick made porch on the western side of the courtyard, was constructed under the orders of a minister Khajeh Shamseddin Balijeh Semnani and the dome by Khajeh Abu Saeid; the former during the reign of Soltan Shahrokh Teimoori and the latter in the times of Soltan Sanjar. There is an inscription on the upper portion of the porch, under which are a few huge tablets of stone. Two of which are decrees of the Safavid monarch to the public. The area for nocturnal prayers in the southern section has sixteen round pillars in the center and eight and a half columns towards the eastern wall which form the pillars of the ceiling in this vicinity. This portion was constructed during the times of Arqoon Khan, under the supervision of his minister Sheikh Alaoddoleh Semnani.

The same was repaired during the reign of Fathali Shah Qajar under the orders of Zulfaqar Semnani. To the south east of this area is the Saljuqi minaret, currently rising to the height of 31.20 m. and with a circumference of 5.5 m. On the top of this minaret is an inscription affixed on the intricate brick work, showing the date of construction. The crown of the minaret is octagonal, with arches in brick works, in addition to the blue tiles. The area where the 'Azan' or the call for prayer is read is railed off with a beautiful wooden latticed worked railing.

Fig. 3 Jame' mosque

Lets back to the main topic, 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 [3].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.

II. 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 [4].

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.

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) 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.

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.

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.

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.

III. 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 [5].
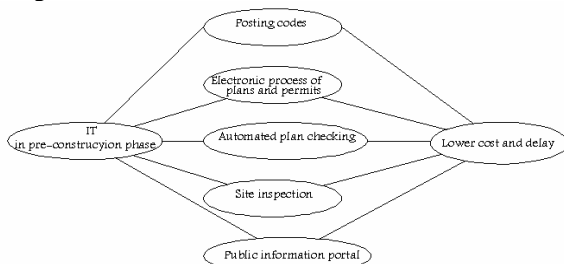

Fig. 4 Role of IT in pre-construction phase

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 [6].

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.
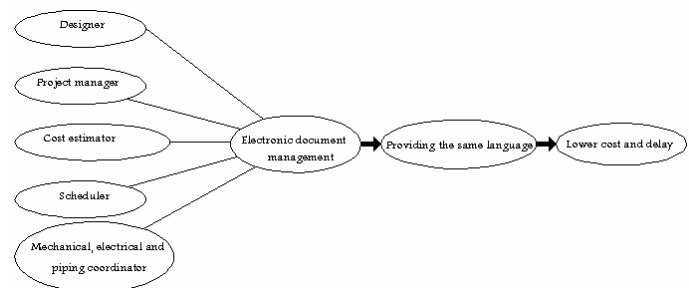

Fig. 5 Role of IT in construction phase

IV. 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. Semnan is in zone 3 too. 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 [7].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 [10].

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 [11].

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.

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.

2)Praperdness

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.

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.

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.

Figure 7 shows one of the checklists that are completed by civil engineers in Semnan municipality for energy optimization.

Fig. 6 The process of recovery and reconstruction

Fig. 7 One of the energy check lists

V. CONLUSIONS

Semnan city needs to a special programming for construction of buildings, structures and infrastructures. Semnan municipality tries to begin this program. In addition to, city has some historical monuments which can be interesting for tourists. Hence, Semnan inhabitants can benefit from tourist industry. Optimization of Energy in construction industry is another activity of this municipality and the inhabitants who execute these regulations receive some discounts.

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.

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] Inch, 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.