Remote Construction Projects’ Problems And Solutions: The Case Of Sec

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Remote projects have their unique problems that are caused mainly by the remoteness of the project itself thus the loose control over communications and management. This is due to a number of reasons such as lack of management skills, human resources and infrastructure. Little research was undertaken particularly in the gulf region regarding this issue and it has highlighted few unique communications and management problems. This paper investigates the current problems that the SEC, Kingdom of Saudi Arabia (KSA) experiences regarding the management of its’ remote construction sites. It discusses the opinions of contractors and the SEC’s supervision teams regarding the weaknesses in the present communications and management practices. The study found systematic project management problems that have profound negative impact on remote projects’ performance and process. The paper suggests that some of these problems can be sorted out by the use of Advanced Computer based Management Systems (ACMS) and these would improve some project management practices. However, organizational barriers may hinder the potentiality of these systems thus changes to the organization’s management system and practices should be carried out to achieve full benefits.

Key Words: Mobile systems, Web-based project management systems, remote manager, virtual management.

1. Introduction

In spite of rapid progress in the project-management field, a number of negative issues still affect management of construction projects. These issues include use of inappropriate tools and systems for communication, coordination, and management. For example, Yang et al. (2007) suggest that intense need for project information and effective communications by the project team cannot be met by traditional communications and information management systems since these systems have shortcomings and are incapable of fulfilling project duties and objectives. One of these shortcomings is that traditional systems provide limited access to information, which is considered one of the key barriers to successful project management practices (Vadhavkar et al. 2002; Pena-Mora et al. 2009). Recent studies by the Stichting Bouw Research center in the Netherlands (2000) indicate that 6% to 7% of contract expenses are due to failures such as unnecessary inefficient process that do not meet the agreed quality of the end product, and repairs. Many of these failures are caused by inadequate organization and management of the construction process (e.g., a weak coordination of processes and uncertainty about available information) (Wamelink 2002). These shortcomings brought about radical changes to traditional project management and communications methods such that new concepts and methods for managing projects have been invented. One of these concepts is the golden triangle, a concept that initially referred to quality, time, and cost but now extends to include sustainability, project team and stakeholder satisfaction, and health and safety issues.

Remote construction projects exist in many regions throughout the world such as the Sahara desert, Antarctic regions, the Arabian Peninsula desert, etc. The dilemma in managing remote projects is highlighted by Deng et al. (2001), Kestle and London (2002, 2003), Kestle (2009), McAnulty and Baroudi (2010). These authors have pointed out that the remoteness thus the loose control is major cause of the management problems. They suggested possible causes such as the lack of human resources, infrastructure and experience of how to manage these remote projects. In the KSA, SEC engages in a number of remote construction projects. These projects are of different sizes and
range from electric power plants to warehouses and customer service blocks. They are in remote locations with rough terrain such as mountains and deserts. They are far from the supervision team office, the contractor’s office, and major urban concentrations. During construction, all project parties experience countless difficulties and cumbersome management problems. These potential problems negatively affect project quality and cause substantial delays and increases in costs. The literature review suggests that some of these management and communications problems can be sorted out by the use of Advanced Computer based Management Systems (ACMS) such as mobile and Web-based Project Management Systems (WPMS). They have also helped fulfill project objectives such as quality, scope, time, and cost. This research investigates remote projects of SEC as a case study. Case study research provides in-depth investigation of the research problem and is used to explore causation to find underlying principles (Yin 2009).

1.1 Review Of Current Remote Projects Management Practices

The dilemma of managing remote projects is highlighted by Deng et al. (2001), who mentions that the extensive physical distance between project participants, sometimes extending over national boundaries, is the primary cause of delays in decision making. The project team has to not only tackle traditional management problems but those that specifically occur as a result of the remote locations of these often environmentally sensitive sites (Kestle 2009; Kestle and London 2002, 2003). These sites are often far from logistic support and suffer a continuous shortage of materials and specialized labor (Kestle and London 2002, 2003). Kestle (2009) investigates the management problems of remote project through two case studies: one a humanitarian project in West Darfur, Al Sudan and the other a drilling project of a scientific expedition in the Antarctic region. Kestle (2009) reports lack of project pre-planning, certainty, and/or clarity concerning project process integration. There were also misinterpretations and miscommunications of project results and needs issues. A centralized decision-making process and lack of delegated authority to field personnel often hindered progress and communications at critical emergency response and recovery stages. Kestle & London (2002) suggest a framework for the design management of remote sites. The framework emphasizes the following management functions: serving, controlling, organizing and economizing. McAnulty and Baroudi (2010) conduct a survey of top and mid-tier construction contractors with experience in remote construction projects in Australia. They found that contractors experience difficulty attracting and retaining skilled workers; working in remote locations has a negative impact on an employee’s family life. It is difficult to procure and access materials and equipment in remote areas and severe climatic factors in remote areas have a negative impact on productivity. There is lack of infrastructure and communications. The researchers suggest a number of possible solutions such as the need for appropriate material management systems and design cost information specifically for remote construction works. They recommend that unique types of costing issues should be included in the project’s cost estimation at the pre-construction stages of project; these include: mobilization/demobilization, accommodation, inclement weather downtime, site allowances, delivery, and productivity.

1.2. Review Of The Current Use Of ACMS

Some of a remote project management’s problems can be avoided if ACMS were used. These systems include WPMS and mobile systems that feature mobile tools, personal digital assistants (PDA), wearable computers, wireless tools, four dimensional augmented reality and other technologies. These systems possess the capability to improve communications between project team members and enable teams to share information and quickly solve problems. They improve team members’ ability to manage time and costs (Charoenngam et al., 2004). Davidson & Moshini (1990) and Bowden (2005) state that construction costs can be reduced by 25% through efficient transfer of information between the construction teams; that transfer can be achieved through ACMS. Ahuja et al. (2010) suggest that adoption of Information Communication Technology (ICT) enables effective communication between dispersed project team members but argues that strategic adoption of ICT (i.e. by a number of organizations involved in the construction process) requires that all supply chain members follow accepted methods of communication or protocols. This enables them to grasp effectively the IT benefits (Ahuja et al., 2009). Alshawi and Ingrige (2003) and Stewart and Mohamed (2004) identify the following benefits of using WPMS: productivity enhancement of communication between project participants, reduction in project delays, heightened awareness of project issues among all parties, and ease of access to and retrieval of project information. Other advantages include: avoiding delays due to the arrival of updated drawings and documents, reducing visits to sites and traveling time to meetings, avoiding drawing mistakes, reducing time and money spent on disputes, sharing and exchanging project
This paper examines a case study that is the remote construction site challenges and how ACMS should be designed to overcome these problems. A number of researchers anticipate that WPMS will replace traditional project management methods (Becerik 2005; Zou and Roslan 2005) and these methods are drivers of WPMS adoption. Several aspects support this claim including increased competitive pressures, expectations of revenue growth, the ability to compete globally, and the desire to reengineer the business to respond to market challenges (Nitithamyong & Skibniewski 2006). Leskien (2006 and 2008) argues that it is difficult to make direct assessment of which mobile systems would benefit the construction industry. The most important intangible benefits include improving customer service, gaining a competitive advantage, acquiring more timely management information, supporting core business functions, avoiding competitive disadvantages, improving management information, improving product quality, improving internal communication, implementing changes through innovation, improving external communication, and enhancing the jobs of employees. In recent years, the development of laser scanning and video and image-based 3D reconstruction system is enabling remote and virtual walk through on actual construction sites. These systems have the ability to minimize the travel times of supervisors and may increase the frequency of progress, quality and safety inspections by providing project supervisors with systems that are easily applicable (Golparvar-Fard et al 2011, Jasek et al 2011). Thorpe (2000) points out that the Online Remote Construction Management (ORCM) process has the potential to be useful to remote construction sites. He mentions that the implementation of ORCM technology should take into account equipment-related and logistical difficulties - particularly on the remote site; access to the Internet, which can be slow or unreliable; legal issues regarding use of electronic communications; cultural issues such as staff reluctance to change existing practices; ORCM systems implementation expenses; and the need for staff training. Despite fast developments in IT and the creation of many IT applications for the construction industry, some issues still hinder the applicability of these systems to construction project management. There is a problem with regard to the diffusion of IT in the construction industry and the absorption of IT into work practices. This includes the level of strategic IT investment by construction industry firms (Alshawi et al. 2009). Other barriers include IT technical shortages, deployment of the system on an ad hoc basis, isolated project management practices, and costly systems (Alshawi and Ingrigie 2003; Nuria 2005; Leskien 2006, 2008). Sidawi and Omair (2010) highlight several barriers to the implementation of WPMS at Royal Commission of Jubail, KSA including staff resistance to change work methodology and processes, low levels of IT infrastructure of the organization and other parties, low computing proficiency levels of senior management & staff, concern for major investment without guarantee of success and/or returns, and preference for old-style paper-based/existing management protocols. To minimize these barriers and enable ICT adoption, the following issues should be investigated (Margherita and Petti 2010):

- Strategy: the action plan deriving from an integrated view of organization’s goals and priorities, people expectations, and potential benefits;
- People: the single individuals’ attitude and the overall organizational context which impact on the level of willingness and readiness to change;
- Process: the real unit of analysis and trigger of change in terms of alternative redesign scenarios and associated impact; and
- Enablers: the potential facilitators of implementation at technological and organizational level

Although there are barriers to IT adoption as highlighted above, the literature suggests that ACMS can impact project management practices positively. Table 1 shows the management problems as highlighted by the literature review and potential ACMS solutions. The following sections discuss remote construction site challenges and how ACMS should be designed to overcome these problems.

2. The research methodology

This paper examines a case study that is the remote construction site’s problems and the potential use of ACMS by the construction department of the SEC. This research is conducted on two stages. Firstly, a pilot study was conducted by the present research in 2009. This is due to the lack of previous research regarding remote projects’
within the Gulf region and the KSA, and to define the possible construction problems thus to formulate questions that are going to be used in the main survey. Secondly, the literature review and the pilot study’s results were used to design the main survey’s questionnaire. The targeted population consists of contractors and SEC’s supervisors/engineers who are located in the four regions of KSA. In 2009, one hundred questionnaire forms were sent randomly out. Twenty five supervisors/engineers and two contractors responded back and this represents 27% of the targeted population. The majority of respondents were SEC’s staff, the results expresses about the views of SEC staff rather than the contractors. Simple statistical tools such as the Percentage and the Mean were used to analyze the data. The study however is limited to SEC’s remote sites whereas SEC’s supervision team members do not live on these sites.

Table 1

<table>
<thead>
<tr>
<th>Management problems</th>
<th>Potential ACMS solutions</th>
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<tbody>
<tr>
<td>The extensive physical distance between project participants, sometimes extending over national boundaries, is the primary cause of delays in decision making (Deng et al. 2001) Lack of project pre-planning, certainty, and/or clarity concerning project process integration (Kestle 2009)</td>
<td>ACMS can improve team members’ ability to communicate and manage time and costs (Charoenngam et al., 2004) ACMS use would reduce cost and save time, enhance communications and collaboration, improve productivity and partnership, and support the e-commerce and the customer (Nitithamyong and Skibniewski 2004, 2006)</td>
</tr>
<tr>
<td>These sites are often far from logistic support and suffer a continuous shortage of materials and specialized labor (Kestle and London 2002, 2003) Contractors experience difficulty attracting and retaining skilled workers; and it is difficult to procure and access materials and equipment and site’s conditions has a negative impact on productivity (Baroudi 2010) Misinterpretations and miscommunications of project results and needs issues; and a centralized decision-making process and lack of delegated authority to field personnel often hindered progress and communications (Kestle 2009)</td>
<td>Construction costs can be reduced by 25% through efficient transfer of information by ACMS between the construction teams (Davidson &amp; Moshini 1990, Bowden 2005) ACMS use enables productivity enhancement of communication between project participants, reduction in project delays, alleviation of awareness of project issues among all parties, and easy access to and retrieval of project information (Alshawi and Ingrige 2003, and Stewart and Mohamed 2004) ACMS use minimizes delays due to the arrival of updated drawings and documents, reduces visits to sites and traveling time to meetings, reduces time and money spent on disputes, automates repetitive routine processes, and eliminates paper reports (Alshawi and Ingrige 2003, and Stewart and Mohamed 2004)</td>
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3. Shortages of SEC’s remote project management practices and systems

In KSA, SEC has a number of remote construction projects. The respondents were asked about the criteria that they use to define a construction project as a remote project. In regards to the travel time from the main office or branches; around 49% said it is from 100-300 km and 37% said it is from 301-600 km. In respect to the travel time; 74% said it is from 1-4 hours and 26% said it is more than 4 hours. The construction process of the remote projects is divided into the following stages: site work; concrete work, masonry work, insulation materials for heat and humidity work, openings (e.g. doors and windows) work, finishing work (e.g. walls, ceilings, and floors), mechanical work (e.g. plumbing, air conditioning, and fire protection), electrical work, and telecommunications and computer work. SEC adopts a management methodology for remote projects similar to those of traditional projects. The pilot study revealed the following issues:
The SEC’s supervisors sometimes postpone the site visit due to the long travel time of 4 hours and more two-way trip and being overloaded with responsibilities. The unsupervised contractors utilize this opportunity to use improper construction materials and construction systems; there is a lack of contractor’s commitment to the project schedule; the lack of construction materials forces the contractor to regularly leave the project site to provide it. This makes the site vulnerable to theft and the records show that there have been several cases of theft; the remoteness of the site hinders government officers from making frequent visits to the site; in some remote areas, the ownership of a plot of land is vague. Thus, SEC possesses the land. Afterwards, a claim of the land’s ownership by a citizen supported by the approval of the Sheikh (head) of one of the local tribes at the area of the project would raise a legal conflict over the land ownership and causes substantial delay to the project; and the delivery of materials and equipment is constrained by the Roads/highways regulations. This enforces the contractor to deliver materials in several batches which increases the delivery and transportation cost. In addition, bad conditions of some roads add more difficulties.

The pilot study revealed that SEC’s supervisors use e-mail to communicate with the director of the regional office. Branch managers are not authorized to undertake decisions regarding a specific site’s queries and decisions are left entirely to the director of the regional office. This substantially prolongs the decision-making period. The primary survey found that queries take four to six days to be sorted out during finishing, concrete, insulation, openings, mechanical, and electrical work stages. 33% to 41% said that queries during the mechanical and telecommunications/computers work stages take one to two weeks to be sorted out. Respondents agreed that the delay in sorting out queries negatively affects project performance - represented by cost, time, scope, and quality criteria - and the project process. Arranged from greatest to least, the most negative impacts are in regard to the delay in sorting out the following queries (see table 2):

- Mistakes in construction works
- Poor quality of construction works (project performance only)
- Selection of unskilled workers by the contractor
- Equipment shortages
- Unavailability of materials
- Low productivity of workers
- Changes to specifications/specified materials (project process only)
- Ineffective planning and scheduling of the project by the contractor
- Breakdown of site equipment (project performance only)

It is found that ACMS are of little use to contractors and supervisors. Most of the respondents (70% to 89%) said they use traditional communication systems and tools such as fax machines, mobile phones, site visits, weekly/monthly reports, and weekly/monthly meetings to manage jobs and communicate between the remote project site and the supervision office. They do not use mobile systems and tools apart from mobile phones, which are used by 93% of the respondents. None of the respondents uses web cams or construction robots on site. The WPMS is not used and e-mail services were used by only 67%. Respondents indicated that electronic communications and management systems are widely unused among project team members.

With regards to the potential use of ACMS, 82% of respondents recommended use of e-mail services. 74% recommended use of mobile tools, 40% to 48% recommend use of walkie-talkies, fax, and web monitoring cameras, 22% to 30% recommend use of personal digital assistants and tablet computers, and 33% recommend use of WPMS. Respondents said ACMS would be especially helpful in sorting out the following construction problems: mistakes in construction works, delays in the project timetable, changes to the project’s scope, changes to the specifications/specified materials, and increases in the costs of materials during construction. Generally speaking, the implementation of ACMS would have positive impact on various aspects of the project (see figure 1). However, the respondents were concerned about the impact of implementation of electronic project scheduling; and communication and exchange of information tools on the project cost (see figure 1). They said that the barriers that hinder the implementation of advanced electronic management and communications systems in SEC are primarily the management system (i.e., the organizational structure and practices); concerns over technical issues such as cost, maintenance, and support; difficulty in making changes to the organization’s structure, internal influences, external pressures; and the level of staff IT skills (see figure 2).
4. Discussion and conclusion

The findings of this research are discussed emphasizing the potential benefits of ACMS to SEC and the barriers that limit the applicability of ACMS to SEC’s construction project management; special emphasis is given to how these barriers can be overcome. This study suggests that the construction department at SEC experiences a number of unique problems. Other researchers such as these mentioned in the literature review (i.e. section one) report similar problems. These problems can be categorized as follows: human resources; cost, time, scope, and quality management; procurement and risk management; and; infrastructure and communications.
Table 2

The degree of impact of the delay in sorting out remote site queries/problems on the project process and performance (Column number two scale: 1, does not affect, 2 somehow affects and 3, heavily affects. Column number three scale: 1 positive, 0 neutral, -1 negative)

<table>
<thead>
<tr>
<th>Type of queries/problems</th>
<th>Level of negative impact of the delay on project process</th>
<th>Mean value of the negative impact of the delay on project performance (represented by cost, quality, scope, and time criterions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mistakes in construction works</td>
<td>2.63</td>
<td>-0.48</td>
</tr>
<tr>
<td>Poor quality of construction works</td>
<td>2.62</td>
<td>-0.24</td>
</tr>
<tr>
<td>The selection of unskilled workers by the contractor to work on site</td>
<td>2.54</td>
<td>-0.44</td>
</tr>
<tr>
<td>Shortage in site equipment</td>
<td>2.54</td>
<td>-0.39</td>
</tr>
<tr>
<td>Unavailability of materials</td>
<td>2.52</td>
<td>-0.46</td>
</tr>
<tr>
<td>Low productivity of the workers</td>
<td>2.48</td>
<td>-0.49</td>
</tr>
<tr>
<td>Changes to specifications/specified materials</td>
<td>2.44</td>
<td>-0.23</td>
</tr>
<tr>
<td>Ineffective planning and scheduling of the project by the contractor</td>
<td>2.42</td>
<td>-0.39</td>
</tr>
<tr>
<td>Improper construction methods implemented by the contractor</td>
<td>2.38</td>
<td>-0.32</td>
</tr>
<tr>
<td>Problems related to the transportation of materials to the site</td>
<td>2.3</td>
<td>-0.36</td>
</tr>
<tr>
<td>Delay in the approval of contractor submissions by the SEC engineers</td>
<td>2.26</td>
<td>-0.25</td>
</tr>
<tr>
<td>The increase in materials’ cost during the building’s construction</td>
<td>2.22</td>
<td>-0.27</td>
</tr>
<tr>
<td>Change of the project’s scope by the contractor</td>
<td>2.15</td>
<td>-0.19</td>
</tr>
<tr>
<td>Unavailability of SEC engineers on the remote project’s site due to their workload</td>
<td>2.15</td>
<td>-0.34</td>
</tr>
<tr>
<td>Delay in the project timetable</td>
<td>2.11</td>
<td>-0.3</td>
</tr>
<tr>
<td>SEC tendering system that obligates the choice of the lowest bidding value</td>
<td>2.08</td>
<td>-0.19</td>
</tr>
<tr>
<td>Inadequate equipment used</td>
<td>1.96</td>
<td>-0.29</td>
</tr>
<tr>
<td>Delay in conducting of the field survey by the contractor</td>
<td>1.92</td>
<td>-0.29</td>
</tr>
<tr>
<td>Unavailability of SEC engineers during sample testing</td>
<td>1.88</td>
<td>-0.35</td>
</tr>
<tr>
<td>Personnel safety issues</td>
<td>1.85</td>
<td>-0.06</td>
</tr>
<tr>
<td>Breakdown of equipment on site</td>
<td>1.81</td>
<td>-0.42</td>
</tr>
</tbody>
</table>
Figure 1: Potential positive/ negative impact of ACMS implementation on various aspects of the project (Scale: cost and time aspects: -1 increase, 0 neutral, 1 decrease; quality and scope aspects: 1 increase, 0 neutral, -1 decrease)

This researcher recommends these actions at the various levels. On project level, the design and pre-planning of site activities such as supply and human resources should consider the environment and project variables mentioned above. Flexible decision-making mechanisms should be created and tested. Present project management practices should be redesigned and remote manager abilities should be improved. SEC should consider short and long-term partnering with contractors. This includes linking systems and sharing information and management tools. This would enhance knowledge integration and help to foster innovative ideas that dramatically improve projects (Barlow 2000). During the construction stage, precise daily control and follow-up procedures should be applied regarding issues such as remote examination of work quality, monitoring productivity of site workers, and calculation of material consumption rates. Some problems seem to be generated during other stages of the project; some are expected such as recruitment of skilled workers, transportation of materials, and other unforeseen problems such as possible shortages in manpower and breakdown of equipment. These should be studied and resolved at the initial planning stages of the project. Emergency scenarios should be established at the early stages of the project to deal with unexpected issues. Prior to any engagement, SEC should draw the contractor’s attention to the unique problems and foreseeable issues associated with the construction of remote projects. In regards to the staff level, the research sees that proper plans should be adopted for SEC’s staff and contractor training; staff should be informed about the benefits and advantages of new ACMS systems. Managers should be trained on how to manage remote sites virtually. In respect to the ACMS implementation and use level, the design of the new ACMS should be discussed with the SEC contractors and supervisors and to find out their views, perceptions and expectations. This would take into account the present remote project’s processes and future scenarios for project processes.
The management system (i.e., structure and practices)

Concern regarding technical issues such as cost, maintenance, and support

Difficulty in making changes to organisation’s structure

Internal influences

The level of IT skills of staff

External pressures

Internal influences

Difficulty in making changes to organisation’s structure

Concern regarding technical issues such as cost, maintenance, and support

The management system (i.e., structure and practices)

Figure 2: Barriers that hinder the implementation of advanced electronic management and Communications systems in SEC. Scale: 1 does not hinder to 5 highly hinder

The ACMS design should consider how to reduce the negative impacts of the project and environment variables on project performance and processes as highlighted in the literature review and this research. To minimize the current barriers and the negative impacts on projects, ACMS should be capable to offer help on two levels: a) vertically during the project life from the design and planning stages through the tendering stage until the occupation/use stage and b) horizontally by integrating all the project parties’ systems, knowledge, and information along the supply chain. This researcher understands the limitations of the case study presented in this paper with regard to the number of participants. However, this could be used as foundation work for future research, which investigates in-depth the problems and possible IT solutions for other remote projects in KSA.

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