Comparative Study of Information Technology Use by Architects, Engineers and Contractors

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Abstract: The use of information technology (IT) in construction is expanding rapidly. More and more architecture, engineering, and construction companies are adopting new technologies in software design to help accelerate and accurately carry out their functions. Based on a research study carried out in Southern Nevada with a questionnaire survey of 54 construction-related firms, this study aims to compare the types and extent of IT use by architects, engineers, and contractors. It also explores the level of IT skills possessed by professionals working in the industry. The study found that architects mostly used design software whereas engineers and contractors used scheduling and estimating software. All of the respondents believed that IT helped to improve their work productivity. The majority of the respondents thought that IT is useful for Construction Management (CM) students: engineers and architects thought that CM students should take more scheduling and estimating software courses and contractors thought that they should take more scheduling and quantity take-off software courses.

Key words: Information technology, contractor, engineers, architecture, construction management.

1. Introduction

The study of the use of information technology (IT) applications in construction is becoming prevalent. Various studies have been conducted to determine the use, benefits, and costs of IT in the construction industry. However, few studies have compared how different sectors of the construction industry use IT and also their perception with regard to IT education.

In the last few years, Southern Nevada has seen an influx of construction companies working on projects, especially on the Las Vegas Strip. These construction projects are multibillion-dollar projects that are very complex in detail and performance. One of the largest privately built projects, City Center, cost $8.5 billion and opened in January 2010. This paper investigates the type of construction software used by the construction industry in Southern Nevada with special emphasis on architects, engineers, and contractors.

The software used by these three major groups of the construction industry will be compared, and the benefits of using information technology in construction as well as perceptions regarding IT education will be evaluated.

2. Literature Review

A number of research studies have been conducted regarding IT use by the construction industry. The authors analyzed the data from 70 Malaysian construction industry firms and found that the construction industry used the Internet as much as other industries [1]. They found that the respondents had good accessibility to the Internet; however, the main use of the Internet was for email and information searches only. This study indicated that Internet users experienced time and cost savings as well as increased efficiency.

An IT barometer survey compared results from
Denmark, Finland, and Sweden on the use of computer hardware, software, and communications [2]. Microsoft products dominated both operating systems and office applications in all these countries; in Finland, there was greater use of software like Windows NT and UNIX. AutoCAD was used in almost all design offices in Sweden, but Micro station was more widely used by architects in Denmark. CAD data structures were becoming more advanced with objects being used by more firms in Finland and Sweden; however, structured 2D data dominated in Denmark. Communications networks were used in about 90% of Swedish firms, but only in about 60% of Danish firms.

Feng analyzed the application of IT in China’s construction industry [3]. This study found that the main use of IT in construction was office software, computer-aided design (CAD), tools software, and communication networks. Tools software includes cost evaluation software, quota management software, quantity calculation software, and steel quantity calculation software. The fastest growing area of IT in China was Internet-based communication. Most construction firms were connected to external networks, the Internet in particular. Furthermore, this study indicated significant barriers to implementing IT in China’s construction industry, and suggested some possible coping strategies that include:

1. Increase government capital expenditure into the telecommunications infrastructure;
2. Promote IT education and the development of human capital;
3. Utilize on-line/web-based information management systems to facilitate a common, efficient data flow systems;
4. Publicize the advantages and quantify the benefits in adopting IT-based communication systems;
5. Develop an IT implementation policy, push for tax concessions to encourage the industry to invest in IT, and conduct industry forums to raise IT awareness among small and medium enterprises.

Authors conducted a study to determine the use of project management software in the construction industry [4]. This study analyzed data from 42 firms in the construction industry and found that construction professionals used Primavera (51.4%) more often than Microsoft Project (24.3%). The study also found that project complexity was the most influential factor affecting the usage of project management software. Other factors that affect usage were software capabilities, size of projects, and requests by clients to use software.

Regarding the construction industry in Finland, a study by Lautanala et al. estimated the potential benefits of IT [5]. This study found if the use of IT was increased during design and engineering phases, this could result in a 128% cost savings throughout other phases, such as contracting. Four mechanisms were identified that contributed to cost savings when using IT technology: (1) the automation of information work; (2) the facilitation of learning processes and the reduction of waste; (3) the interoperability and transparency of information; and (4) synergy impacts.

Goh conducted a survey of 84 construction contractors to determine the level at which IT has been generally adopted in the Singapore construction industry [6]. The findings of this survey were compared with that of Denmark, Sweden, and Finland [7, 8]. This study indicated that 98 percent of Singapore construction personnel used personal computers. Also, personnel of Singapore companies have more access to the Internet than their Swedish counterparts, but less access than their Danish counterparts. Fewer companies in Singapore will invest in IT as compared to those in Nordic countries. Also, companies in Singapore will consider new IT investments to improve technical capability whereas Danish companies will invest more in improving customer satisfaction.

The review of literature regarding the use of IT by the construction industry revealed that no research
was conducted comparing IT use by three sectors of industry, namely architects, engineers, and contractors [9-11]. This study is designed to fulfill this objective.

3. Scope and Objectives

The scope of this study is to conduct a questionnaire survey with architects, engineers, and contractors working in Southern Nevada. This questionnaire sought the following information:
- General information about the respondents,
- Use of electronic devices,
- Education level and skills of IT staff,
- Use and benefits of construction related software,
- Perception of the construction industry towards IT.

The objectives of this study include:
- Compare the type and extent of electronic devices used in construction-related work by these three different sections of the construction industry.
- Compare IT skills and the educational level of construction professionals working in these sections of the industry.
- Compare the construction-related software used and its impact on the productivity of the companies.
- Compare the perception of these sectors of the construction industry regarding IT education.

4. Survey Method

4.1 Development of Survey Questionnaire

The survey questionnaire utilized in this study was developed by the two senior authors while in the Construction Management Program at the University of Nevada, Las Vegas (UNLV). The survey questionnaire was divided into five sections.
- In Section I, “General Information”, respondents provided information regarding company size and the services they provide. In addition, personal contact information was requested for possible follow-ups.
- Section II, “Use of Electronic Devices and Computer Training Facility”, determined what devices were used by each company and whether that company had a computer training facility.
- Section III, “Information Technology Uses and Skills and Education Level of Staffs”, investigated the prevailing software in the construction industry. This section collected data regarding the skill and education levels of the IT professional working in the industry.
- Section IV, “Uses and Benefits of Construction-related Software”, identified construction-related software that are not known by most practitioners in the industry but are used by architects, engineers, and constructors. It also determined the major benefits in using that software.
- Section V, “Perceptions of Construction Industry towards Information Technology”, covered the perception of the construction industry towards IT education. In this section, the respondents were asked to suggest how many credit hours of coursework relating to IT should be taken by Construction Management (CM) students in order to prepare them for professional careers in construction. The final part of this section of the questionnaire was designed to provide an indication of what should be considered for inclusion in future construction management curricula.

The survey questionnaire was designed using Adobe Designer so that respondents could send their responses by means of email. Therefore, the questionnaires did not need to be printed out and filled in. The majority of the questionnaire responses came back by email rather than by postal delivery. However, some questionnaires were mailed back; in addition, graduate students visited the office of the respondents in order to collect the completed questionnaires.

4.2 The Mailed Questionnaire Survey

This survey mainly targeted contractors, engineers, and architects. The questionnaires were sent to 80 contractors, 40 architects, and 50 engineering firms working in Southern Nevada in 2008. Emails and postal delivery was used to send the questionnaires to the target population. The questionnaires were distributed to the members of local chapters of the
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Construction Management Association of America (CMAA), American Institute of Architects (AIA), Associated General Contractors (AGC), and the UNLV Construction Management Advisory Board. The questionnaire also was posted on the AGC website. The respondents were selected randomly; there was no pre-screening of the respondents.

4.3 Responses of the Mailed Survey Questionnaire

The responses of questionnaire were collected either by email or by postal delivery. It took approximately a year to collect the data. Fifty-four responses were received. The maximum number of responses received was from construction contractors. Engineering firms was the second largest group who submitted questionnaires. Table 1 shows the detailed breakdown and percentage of the respondents. The response rate was about 32%, which is relatively good in terms of survey questionnaire responses.

4.4 Data Analysis

The data were entered in the Statistical Package for Social Science (SPSS) software and also in an Excel spreadsheet. Any data that were not consistent was corrected by follow-up emails or phone calls. Once the data were entered, then they were analyzed. The charts were prepared from the Excel spreadsheet, and the data were analyzed using SPSS. In addition, the data analysis report was sent to the respondents in order to get feedback from them about the survey results.

Table 1  The rate of response for the survey.

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of Companies Questionnaire was sent to</th>
<th>No. of Responses</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architects</td>
<td>40</td>
<td>13</td>
<td>32.5</td>
</tr>
<tr>
<td>Engineers</td>
<td>50</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Contractors</td>
<td>80</td>
<td>26</td>
<td>32.5</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
<td>54</td>
<td>31.8</td>
</tr>
</tbody>
</table>

5. Results

The results of the survey conducted are discussed below. The results are discussed into five sections, reflecting the five sections in the questionnaire. While filling out the questionnaires, all the respondents did not respond to all of the questions. Therefore, not every analysis contains data from the 54 respondents.

5.1 Section I: General Information

The construction contractor/subcontractor is the largest group of respondents. While grouping the data, it is important to mention that all the subcontractors, engineering contractors, residential contractors were grouped as Contractors. All the architects involved in the design of the building were grouped as Architects. All the engineering firms involved in designing, consulting, and providing construction management services were grouped as Engineers. According to the data analysis, the construction contractors constituted 48% of the total respondents. Engineering firms constituted 28%, and architectural firms constituted 24% of the total respondents (Fig. 1).

The results showed that the respondents were involved in different types of projects (Fig. 2). The major types of projects were commercial buildings, residential buildings, industrial buildings, and heavy highway and civil construction. In Las Vegas, the construction of commercial buildings was increasing during the time of survey; therefore, the majority of the respondents worked in the commercial sector at that time. About 75% of the responding contractors and engineers were involved in commercial building construction. 60% of the architects were involved in designing commercial buildings. Fewer contractors,
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5.2 Section II: Use of Electronic Devices and Computer Training Facilities

The main devices used by the respondents were desktops, laptops, PC tablets, personal digital assistants (PDAs), and smart phones. Fig. 3 shows the breakdown of these devices owned by the different sectors of construction industry. One hundred percent of the contractors, engineers, and architects have desktops in their offices. Approximately 90% of the contractors, engineers, and architects have laptops. Engineers were the largest group having PC tablets (30%) and PDAs (38%). Contractors (90%) used smart phones more than any other group of respondents. Overall, almost all of the contractors, engineers, and architects used desktops and laptops.

Fig. 4 shows the breakdown of computer facilities available in Las Vegas offices for employee training. The data shows that engineers (48%) were the largest group having computer training facilities in their offices. Only 8% of the architects have computer training facilities in their office. About 27% of the contractors have computer training facilities in their offices. Overall, about 28% of the respondents have computer training facilities in their offices.

The construction industry used various methods to offer computer training to their employees. Fig. 5 shows the breakdown of the computer training methods adopted by the respondents. In terms of outsourcing computer training, the results show that the contractors were the largest group (27%). An equal percentage of the contractors, engineers, and architects, 50% each, provided in-house computer training to their employees. Regarding on-the-job computer training, the largest group was architects (45%). Contractors were the only group that used all three methods to train their employees (5%). Overall, most of the respondents (50%) trained their employees in-house.

5.3 Section III: Information Technology Uses and the Skills and Education Level of Staff

The respondents used computers in their daily work varying from a few hours to 10 hours. Fig. 6 shows the types of projects involved (N=54).
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Fig. 3  Types of electronic devices used (N = 54).

Fig. 4  Availability of in-office computer training facilities (N = 54).

Fig. 5  Methods of computer training (N = 54).
breakdown of the computer usage in the office every day for different group of respondents. The analysis shows that the majority of architects (62%) used computers more than 6 hours every day, followed by contractors (46%). About 73% of engineers used computers 3 to 6 hours every day in their office. Overall, about 91% of contractors, engineers, and architects used computers more than 3 hours every day in their offices.

The computers are used for performing various types of work in offices. The four major types identified in this survey are: (1) normal office work, such as administrative work and email; (2) design work; (3) running construction-related software; and (4) running software for research purposes. Table 2 shows the detailed breakdown of these various types of work performed by the contractors, engineers, and architects. The results showed that 100% of the architects used computers for normal office work, compared to 73% of the contractors and engineers. The majority of architects (85%) used computers for design, estimating, and scheduling work. 38% of the contractors used computers for running software for research purposes. Overall, the top three common uses of computers by the respondents were normal office work (80%) and running estimating and scheduling software (70%).

The types of software used for various tasks included administrative, scheduling, estimating, request for information (RFI) submittals, on-screen take off, spreadsheets, accounting/financial, risk analysis, presentation, building information modeling (BIM), and graphics/visualization software. Table 3 shows the detailed breakdown for the percentage of different types of software that was used by contractors, engineers, and architects. One hundred percent of the contractors used computers for performing administrative work, scheduling, estimating, and running spreadsheets. The top three types of software used by engineers were administrative (92%), spreadsheets (92%), and scheduling (77%) software. Eighty-five percent of the architects used computers for administrative tasks, presentations, BIM, and graphics/visualization. The data analysis showed that contractors used construction-related software for scheduling and estimating, and engineers used software for administrative tasks and spreadsheets. Architects used design-related software.

Table 4 shows the IT skill level of the staff in running different types of software. The survey results indicate that everybody was skilled in using word processing. However, more people in construction (94%) and engineering firms (93%) were skilled in

![Fig. 6 Amount of time spent using computers owned by architects, engineers, and contractors (N = 54).]
using software for spreadsheets than in architect firms (85%). More architects (100%) were skilled in using presentation software than engineers (92%) and contractors (62%). The architect firms and engineering firms both had 100% of their people skilled in using graphics/visualization; however, only 62% of people in construction companies were skilled enough to run graphics/visualization software. 100% of contractors were skilled in using construction-related software for estimating and scheduling and also word processing software. Only 92% of the architects and 85% of the engineers were skilled enough to run the construction-related software.

The respondents were asked to compare their employees’ IT skills with their peer companies. The results of this analysis are shown in Fig. 7. Engineers (53%) and contractors (27%) responded that their employees were less or much less skilled in comparison to their peer groups. Architects responded
that no employees in their company were less or much less skilled in comparison to their peer groups. Contractors (50%) and architects (38%) responded that their employees were more or much more skilled than their peer groups. For this sample, it showed that engineering firms’ IT employees were less or much less skilled in comparison to their peer groups.

The education level of employees involved in the IT was collected. The respondents identified their IT employees without college degrees, undergraduate degrees, or higher degrees. As shown in Fig. 8, engineers (60%) had the highest percentages of IT employees having at least an undergraduate degree. Architects (31%) had the lowest percentages of IT employees with a college degree. The overall data shows that 52% of the respondents had IT employees with at least an undergraduate degree.

### 5.4 Section IV: Uses and Benefits of Construction-Related Software

This section was designed to determine the types of construction-related software uses as well as the types

![Fig. 7 Comparison of employee IT skill level in architecture, engineering and contractor firms (N = 54).](image1)

![Fig. 8 Comparison of the education level of IT employees in architecture, engineering and construction firms (N = 54).](image2)
of benefits resulting from their usage. Table 5 shows a
detailed breakdown of the top four design software
used by the respondents. About 57% of the
respondents used AutoCAD products for designing
the projects. Other design software used were Revit
(20%), 3D Studio MAX (13%), and Google Sketchup
(11%). Twenty percent of the respondents did not
conduct design work in their office. The data analysis
shows that architects were heavy users of Autodesk
products (92%). They also used Google Sketchup
(46%), 3D Studio MAX (46%), and Revit (46%) for
designing projects. Contractors used design software
very often, and most of them used Autodesk products
(27%) or Revit (15%). There were a number of other
design software used by the respondents, such as
MicroStation, Traffic Design Software, and
Pro/Engineer; however, their use was limited to one or
two respondents.

The respondents used 16 different types of
estimating software. Table 6 shows the top four
estimating software used by the respondents, and the
detailed breakdown of uses by sectors of industry.
Most respondents (31%) used Microsoft Excel. More
contractors (46%) used Microsoft Excel than
architects (31%) and engineers (7%). 15% of the
contractors used On-Screen Take-Off software for
estimating purposes, and 12% of the contractors used
Timberline software for estimating. Only 31% of the
architects used Microsoft Excel; 7% of the engineers
used Microsoft Excel, 7% used Timberline, and 7%
used On-screen Take-off software. 46% of the
engineers and 46% of the architects did not use any
estimating software in their offices. Other types of
estimating software used, mostly by contractors,
included MC2, Autodesk, Deltek, HeavyBid, Hard
Dollar, WinEst, and BidTek.

Table 7 summarizes the use of scheduling software
by the respondents. Majority of the respondents (54%)
used Primavera to prepare the schedule for projects.
About 28% of the respondents used Microsoft Project,
and 22% of the respondent did not use any scheduling
software. In analyzing the data by types of users, the
results show that majority of the contractors (77%)
and engineers (53%) used Primavera to schedule their
projects. Usage of Microsoft Project was greatest
among engineers (40%) and architects (38%).

Table 8 shows the use of software for Requests for
Information (RFIs). The majority of the respondents
(31%) used Expedition to submit RFIs. About 26%
percent of the respondents used Microsoft Excel/Microsoft Project to submit RFIs. The top five
RFI submittal software used by the industry is shown in
Table 8. The contractors (27%) used Expedition and
Microsoft Document for RFI submittal. Engineers used
Expedition (47%) more than Microsoft Document
(13%). Architects used Microsoft Document (38%)
more than Expedition (23%). About 20% of
respondents did not use RFI software in their offices.

<table>
<thead>
<tr>
<th>Table 5 Types of design software used (N = 54).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autodesk products (%)</td>
</tr>
<tr>
<td>Contractors</td>
</tr>
<tr>
<td>Engineers</td>
</tr>
<tr>
<td>Architects</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6 Types of estimating-related software used (N = 54).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft excel (%)</td>
</tr>
<tr>
<td>Contractors</td>
</tr>
<tr>
<td>Engineers</td>
</tr>
<tr>
<td>Architects</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>
Table 7  Types of scheduling software used (N = 54).

<table>
<thead>
<tr>
<th></th>
<th>Primavera (%)</th>
<th>Microsoft Project (%)</th>
<th>Do not use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td>77</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Engineers</td>
<td>53</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Architects</td>
<td>8</td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>Average</td>
<td>54</td>
<td>28</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 8  Types of Request for Information (RFI) software used (N = 54).

<table>
<thead>
<tr>
<th></th>
<th>Microsoft Document (%)</th>
<th>Timberline (%)</th>
<th>Prolog (%)</th>
<th>Expedition (%)</th>
<th>Adobe (%)</th>
<th>Do not use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td>27</td>
<td>8</td>
<td>12</td>
<td>27</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Engineers</td>
<td>13</td>
<td>7</td>
<td>0</td>
<td>47</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>Architects</td>
<td>38</td>
<td>0</td>
<td>0</td>
<td>23</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Average</td>
<td>26</td>
<td>6</td>
<td>6</td>
<td>31</td>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>

The construction industry use different types of quantity-takeoff software. Table 9 shows the detailed breakdown of the top three quantity-takeoff software used by the respondents. Twenty-one percent of the respondents used On-Screen Takeoff for quantity takeoff. Microsoft Excel and AutoCAD were used by about 21% and 7% of the respondents, respectively. Twenty percent of the engineers used the Autodesk product, 13% used On-Screen Takeoff, and 13% used Microsoft Excel. Eighty-five percent of the contractors used quantity takeoff software; in contrast, 92% of the architects did not use this software.

The survey identified five major benefits from IT usage. Table 10 shows the detailed breakdown of the benefits received by the respondents. 81% of the respondents were able to improve productivity by the use of the IT in their companies. Sixty-nine percent of the respondents said that IT helped them to complete the work conveniently. Fifty percent said that they used IT to be competitive in the market. When the data were analyzed by the type of companies, it showed that the major benefits of use of IT for the contractors, engineers, and architects were improved productivity (80%, 80%, 100%, respectively) and work convenience (72%, 60%, 83%, respectively).

5.5 Section V: Perception of the Construction Industry towards Information Technology

The questionnaire was designed to solicit information from the construction industry personnel about the importance of IT in their future employees. The respondents were asked how valuable is that new CM graduates should have IT knowledge. The majority of the respondents (56%) indicated that it was very or extremely valuable for CM students to have IT knowledge. Six percent of the respondents indicated that it will be somewhat valuable. Fig. 9 shows the detailed breakdown of the responses. According to the contractors’ data, 42% of the respondents indicated that it was very or extremely valuable to have IT knowledge in CM graduates. Sixty-seven percent of the engineers and 69% of
Table 10  Benefits from using Information Technology (N = 52).

<table>
<thead>
<tr>
<th></th>
<th>Improved Productivity (%)</th>
<th>Improved Staff Learning (%)</th>
<th>Work Convenience (%)</th>
<th>Be Competitive Complete Project on Time (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td>80</td>
<td>40</td>
<td>72</td>
<td>68</td>
</tr>
<tr>
<td>Engineers</td>
<td>80</td>
<td>40</td>
<td>60</td>
<td>47</td>
</tr>
<tr>
<td>Architects</td>
<td>100</td>
<td>8</td>
<td>83</td>
<td>25</td>
</tr>
<tr>
<td>Average</td>
<td>81</td>
<td>31</td>
<td>69</td>
<td>50</td>
</tr>
</tbody>
</table>

Fig. 9  Importance of Information Technology knowledge for Construction Management (CM) students (N = 54).

architects/engineers thought that way. The data showed that more architects and engineers felt that it is very or extremely valuable to have IT knowledge in CM graduates in compared to contractors. This is due to fact that architects and engineers used more IT than contractors in their daily office work.

The respondents were asked about the required number of credit hours the CM students should take in the various areas of CM education. Table 11 shows the result of the data analysis. Eight-five percent of the respondents felt that CM students should take 3 or more credit hours of scheduling software class. Sixty-five percent of the respondents said that students should take 3 or more credit hours of estimating software class. Sixty-three percent of the respondents felt students should take 3 or more credit hours of quantity takeoff class. The rest of the percentages not shown in the table indicates respondents who said that these courses are not required for the students.

The data analysis shows that the majority of contractors (92%), engineers (87%), and architects (69%) agreed that scheduling software should be taught more than 3 credit hours to the CM students. Engineers (87%) and architects (69%) also agreed that estimating software should be taught more than 3 credit hours. Contractors, engineers, and architects all agreed that Quantity Takeoff and Spreadsheet software should be taught more than 3 credit hours to CM students. The detailed breakdown of their responses for all the software are shown in Table 11.

5.6 Limitations of the Findings

This survey was conducted with the companies involved in construction the Southern Nevada area. Therefore, care should be taken to interpret this data in any other context. Due to data received from one region of the United States, it would not be appropriate to use the findings of this survey to predict
Table 11  Software education requirements for CM students (N = 52).

<table>
<thead>
<tr>
<th>Name of Software</th>
<th>Contractors</th>
<th></th>
<th></th>
<th>Engineers</th>
<th></th>
<th></th>
<th>Architects</th>
<th></th>
<th></th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 3 CR (%)</td>
<td>3 CR (%)</td>
<td>&lt;3 CR (%)</td>
<td>3 CR (%)</td>
<td>&lt;3 CR (%)</td>
<td>3 CR (%)</td>
<td>&lt;3 CR (%)</td>
<td>3 CR (%)</td>
<td>&lt;3 CR (%)</td>
<td>3 CR (%)</td>
</tr>
<tr>
<td>Scheduling</td>
<td>8</td>
<td>92</td>
<td>7</td>
<td>87</td>
<td>8</td>
<td>69</td>
<td>7</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimating</td>
<td>50</td>
<td>27</td>
<td>7</td>
<td>87</td>
<td>8</td>
<td>69</td>
<td>17</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity Takeoff</td>
<td>38</td>
<td>61</td>
<td>27</td>
<td>67</td>
<td>15</td>
<td>62</td>
<td>30</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreadsheet</td>
<td>42</td>
<td>54</td>
<td>33</td>
<td>67</td>
<td>39</td>
<td>31</td>
<td>39</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFI Submittal</td>
<td>42</td>
<td>46</td>
<td>40</td>
<td>60</td>
<td>15</td>
<td>62</td>
<td>35</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D Design</td>
<td>31</td>
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similar trends of IT use and perception towards it to other regions of United States.

6. Conclusions and Future Research

The survey conducted in this study shows that the construction industry is looking more positively at the use IT, and that the use of computers is becoming prevalent. In this study, 100% of the contractors, engineers, and architects have computers in their workplace. The use of laptops in office also is increasing. About 90% of the contractors, engineers, and architects own laptops that are in their offices. More engineering firms own PC tablets than do contractors and architects. However, more contractors used smart phones, useful in communicating on construction sites, than do engineering and architect firms.

The requirement of computer training for employees was recognized by the majority of the respondents. The survey showed the majority of respondents provided computer training either in-house, outsourced it, or had on-the-job training. The survey data shows that more engineering firms had a computer training facility in their office than did contractors and architects. More contractors outsourced the computer training of their employees to outside companies, while more architects and engineers provided training to their employees in house or through on-the-job training.

The survey data also showed that the use of computers in the work office is very high. The majority of contractors, engineers, and architects spent more than 3 hours per day working at a computer in their offices. Architects used computers for normal office work, design, estimating, and scheduling. On the other hand, contractors and engineers used computers mostly for normal office work, estimating, and scheduling. The software generally used in the office included word processing, scheduling, estimating, spreadsheets. Contractors mostly used estimating and scheduling software, while architects used BIM, graphics/visualization, and presentation software. The respondents viewed their IT employees’ skills as ‘very good’ in using word processing and spreadsheet software as well as construction-related software for estimating and scheduling. Architects and engineers are more skilled in performing graphic/web design and using presentation software than contractors. About one third of the IT employees in architecture firms had at least an undergraduate degree. This is due to the fact that the job description for most architecture firms’ AutoCAD or other design software operators did not require a college degree.

The major types of design software used by architects are AutoCAD, Revit, and SketchUp. Contractors, engineers, and architects all used different kinds of estimating software, although Microsoft Excel was widely used for estimating. In scheduling, Primavera and Microsoft Project were used by the majority of the contractors. Expedition software was mostly used for RFI submittals.
On-Screen Takeoff and Excel were used for Quantity Takeoff.

The main benefits of IT use are productivity improvement, convenience, and the ability to complete the projects on time. Ninety-one percent of industry respondents felt that CM students must receive significant software training as part of their undergraduate education program. According to them, the courses that the students should take 3 credit hours or more in their college curricula are scheduling, estimating, quantity takeoff and spreadsheets. In particular, all the respondents thought that CM students should receive 3 credit hours or more of training in scheduling, estimating, and quantity takeoff software. Perceptions varied according to the type of companies regarding what type of software should be taught in undergraduate courses.

Survey results indicated that the construction industry currently is more dependent on IT in their workplace than in the past. This survey also explored the type of software used in the construction industry and the skill level of the IT staff.

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