3-2013

Current State Of Wireless Information Technology In The Construction Industry In Ohio

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By Alan Atalah and Aaron Seymour

ABSTRACT

Construction projects are increasingly getting complex and fragmented in nature, yet contractors persistently face shortened project durations and reduced budgets. Timely delivery of accurate and reliable information among all project participants is critical and important because information is the foundation upon which decisions are made and projects are estimated, planned, monitored, and controlled. Recent developments in technology promise to introduce efficiencies that were not previously available to the industry. This study seeks to identify the current state of wireless information technology through the analysis of quantitative data from a web-based survey that represents the views of the respondents on the usage and interest in wireless technology.

The study suggests that the level of interest in wireless technology is much higher than the level of use. Wireless technology enhanced the skills, productivity, and customer service of the participants, but did not improve their ability to negotiate projects and monitor project costs. The respondents believe that the return on investment is not a barrier; slow download speeds and durability are the largest barriers keeping people from using wireless technology.

Keywords: Mobile devices, Web-based project management,

INTRODUCTION

The Internet unquestionably represents one of the most important technological developments in recent history. It has revolutionized the way people communicate with one another, obtain information, and has created an unimaginable variety of commercial and leisure activities (Yoo, 2010). Communication technologies that intimidated many of us just a few years ago are now a part of our daily lives. The wide use of cell phone and the Internet in the early nineties, Hotmail in 1997, Skype in 2004, Twitter and Facebook in 2007 are just a few examples of the changes in the way we conduct our personal and professional lives (Marston, 2011). Technological change increases productivity and economic growth, and the focus should be on how new communication technologies affect business (Wallsten, 2010). Information is the cornerstone of any business process (Stewart & Mohamed, 2004). During the last two decades, a wide range of industries experienced significant productivity improvements because of the technological advancement in information technology, which has provided these industries with great advantages in speed of operation, in consistency of data generation, and in accessibility and exchange of information (Mohamed & Stewart, 2003). The majority of construction business processes rely heavily on traditional means of communication such as face-to-face meetings and the exchange of paper documents in the form of technical drawings, specifications, and site instructions (Deng, H. Li, Shen, & Love, 2001). Wasted time and cost in construction projects can, more often than not, be traced back to inadequate, late, or inconsistent handling of information (Mohamed & Stewart 2003). Construction projects often generate 1 to 2 million pages of documents throughout the course of a job. Without the proper means, retrieving pertinent information from these documents is a time-consuming process for anyone involved with a project (Zack, 2002).

The industry recognizes the need to increase the efficiency of its processes via exchanging massive volumes of information at high speed and at relatively low cost (Deng et al., 2001). Although construction companies seek new solutions to remain competitive in the marketplace, the use of information technology (IT) in construction has not progressed to the level that can be seen in other industries (Flanagan, Ingram, & Marsh, 1998). This is due to a number of historical, industrial, and market forces that have perpetuated the industry's culture and affected the adoption of IT in day-to-day business processes (Baldwin, Thorpe, & Carter, 1999).

Many developments toward the convergence of wireless communications and Internet-based technologies have emerged. Mobile collaboration using wireless networking can be very effective at minimizing the impact of the physical dispersion of project managers and site supervisors (Anumba, Aziz, Bouchlaghem, Carillo, & Ruikar, 2006). Research suggests that reductions in project delivery time of 20 to 50 % are possible when enabling technology improves communication between project participants (Wood & Alvarez, 2005).

Knowledge has been identified to be a significant organizational resource, which if used effectively can provide a competitive advantage. The fragmentation of the construction industry (CI) and ad hoc nature of construction projects provides a challenge for operational communication and information processes. Ultimately, the ineffective capture and reuse of valuable knowledge gathered during a construction project inadvertently contributes to project cost increases and time delays. Given the nature of construction projects, collaborative knowledge management seems to be the most appropriate solution to capture project-based knowledge. Information and communication technologies offer a number of solutions to implement collaborative knowledge management solutions. It is suggested that construction businesses must communicate and exchange information more effectively by adopting IT; the adoption of IT reduces project costs, which in turn provides competitive advantage (Love, Irani, Li, Cheng, & Tse, 2001).

Microsoft, Oracle, Sage, Meridian, Autodesk, HCSS and many others firms have developed web-based construction project management applications for the architecture engineering construction (AEC) industry to collaborate, integrate, communicate, and coordinate construction projects during the last decade. However, many construction organizations still face collaboration challenges, including how to bring extended project teams together across geographical locations, in online and offline environments, and across different technology systems and devices. By providing a rich Web-based user interface on a powerful Web services platform, Web-based project management (WPM) applications allow the project team to collaborate more efficiently and give users flexible choices in how they access critical project data.

Electronic document and project management solutions have increased in popularity as a result of these circumstances. Web-based project management (WPM) allows project participants to access relevant documents through the Internet from virtually any location that has Web access. However, the wired access points that are available through the clients' Internet service provider limit the benefits of WPM. The functionality of WPM and other information technology can be greatly improved by increasing the mobile ability of the Internet through the use of wireless information technology (WIT).

WIT consists of networking hardware and software that significantly increase the mobile access to the Internet by eliminating the need for wired access. This can be done either through a cell phone network with data capabilities or a wireless local area network (WLAN) on local modem or Wi-Fi hotspot. The future of digital communication is mobile; anything and everything will be mobile/wireless (Fleishman Hillard, 2009). A construction workforce that is outfitted with wireless technology could gain mobile access to various critical applications, such as construction management (CM) programs, schedules, cost accounting, and documentation management. Several software providers have adapted construction project management software to run on handheld computing devices, allowing the wireless transmission of data from nearly any location that has access to a wireless data network.

Recent price reductions and improvements in information technology and network speed have allowed many progressive contractors to adopt wireless communications and Internet-based technologies in an attempt to improve communication between the office, the job site, and the client (Anumbaet al., 2006). Small businesses today can get broadband Internet service from many communication companies, for example, Verizon Communications, Time Warner, Comcast, AT&T, and others, for $30 to $90, depending on the speed and the amount of data traffic. Verizon Communications, Time

Warner, Comcast, AT&T, and others offer businesses wireless data plans that cost less than $10/GB. These businesses can bundle Internet services with many other communication services for more savings (Verizon Communications, 2012) (AT&T, 2012). In addition, a wireless modem at the job-site office reliably and securely provides cost effective wireless data communication to the machines on the job site or in the office.

These prices are significantly less than what they were a few years back, and this trend is expected to continue into the future. As the competition among technology giants, such as Apple, Microsoft, Google, Samsung, and others heats up and production exceeds demand, the cost of their devices will be lowered and their capabilities will increase. The same competitive pressure among the retail giants, such as Wal-Mart, Best Buy, and Amazon will lower the cost of these devices (Arora, 2012; Smith, 2012; Zeitlin, 2012). The competitive pressure among communication giants, such as Time Warner, Comcast, AT&T, and Verizon will lower the cost of transferring data among these devices.

The recent release of the National Broadband Plan by the Federal Communications Commission (FCC) has focused the attention of industry leaders, academics, and ordinary citizens on having sufficient bandwidth available anytime and anyplace to support a growing array of broadband services. Broadband services include both wired and wireless access to the Internet and the delivery of high-definition, even 3-D, television (Hatfield, 2010). The FCC's National Broadband Plan recommends that 500 MHz of spectrum be made available for broadband within 10 years, of which 300 MHz should be made available for mobile use within 5 years (Hatfield, 2010).

Many research studies support the enhanced communication, faster decision making, and cost savings that result after initiating information technology solutions (Mohamed & Stewart, 2003). Successfully implementing wireless technology in the CI could streamline many operations of the building process by transcending physical distance when accessing or manipulating information. Significant productivity improvements and shortened project durations could be realized as a result (Menzel & Rebolj, 2004).

Most importantly, adopting WIT can greatly improve the service that is delivered to the owners of projects, as they ultimately receive the benefits. Improved customer service can be realized through customizable Web interfaces that are set up specifically for the project owner to review updated drawings, changes in the schedule, and other project data. The owners' demand for the technology is an important factor in the rate of adoption across the industry. If owners begin regularly requesting advanced technology, then the industry will follow (El-Diraby et al., 2004). Research should focus on the economic effects that digital communications have on specific industries, which are more likely to be identifiable and measurable (Wallsten, 2010); in our case, it is the construction industry.

The use of IT in construction has not progressed to the level seen in other industries (Mohamed & Stewart, 2003) likely because the decision-making process behind investing time and money into wireless communication technologies is poorly understood (Bernold, Lu, & Williams, 2006). After analyzing results of similar studies, one could infer that utilizing an efficient and convenient process of accessing data by means of mobile computing can oftentimes be overlooked.

AEC industry professionals may be reluctant to consider emerging technology as a way to improve the bottom line for several reasons. Construction companies with accounting or project management software already in place may be hesitant to make a large investment into new software with wireless capabilities that has not been proven to provide cost-saving benefits within their organization. Some may be dissuaded by the perceived barrier of entry that could exist due to additional training, software support, and hardware purchases. Others may be unwilling because of the apparent legal and security complications that could result from the lack of retaining hard copy documentation with signatures of change orders or approvals (Alshawi & Ingirige, 2003). However, contractors must realize that wireless communication technology has become extremely feasible with regard to both setup

and cost, and a return on their investment can be achieved in relatively little time (Emborg & Olofsson, 2004). In addition, recent court rulings determined that an official document created, stored, or transmitted electronically can be submitted and verified as evidence in a trial (Zack, 2002).

The main objective of the study was to identify WIT utilization among the employers of the graduates of the CM program at Bowling Green State University (BGSU). The improvements in cost, security, reliability, availability, and capability of mobile communication technology are expected to increase the utilization level significantly in the near future.

As stated previously, the recent advancement in WIT in terms of reliability, speed, and affordability enabled many industries and businesses to achieve higher efficiency, cost savings, and profitability. However, the AEC industry has been slower than other industries in the utilization of these advancements (Mohamed & Stewart, 2003). Learning how the AEC industry uses wireless communication technologies, which ones use them, and the obstacles to using them, will benefit both the AEC industry and the WIT industry. The authors aim to help AEC companies by presenting key factors that should be considered prior to a successful investment and implementation. Software and hardware developers can benefit by gaining insight into the AEC users of WIT for continued product development and improvement.

RESEARCH DESIGN

The employed research instrument was an electronic survey to preselected professionals in the CI. The study population consisted of construction professionals that employed the students and graduates of the CM department in the College of Technology at BGSU. The participants worked for general contractors, subcontractors, and CM firms, and they reflect the construction industry in both Ohio and United States. The subjects were familiar with the CM department, and a good percentage of them were graduates of the department. The respondents' participation in the study was kept completely anonymous, and they were free to withdraw at any time. The results were then analyzed with both descriptive and inferential statistics.

DATA COLLECTION INSTRUMENT

The primary data collection instrument of this study was the voluntary Web-based survey, which is shown in Appendix A. The authors, who are active members of the construction industry, formulated the questionnaires after conducting an extensive review of literature and surveying the available technology in the marketplace and the technologies used in the construction industry. The Human Subjects Review Board (HSRB) at BGSU approved the survey prior to conducting the research. By beginning the survey, the subjects were giving consent to participate in the study, and they were permitted to skip questions or discontinue participation at any time. The electronic survey service anonymously recorded IP addresses to ensure eligible participation and to allow the tracking of unique access without placing a burden on the participant.

Motivating respondents was an important aspect of this study, and the researchers took several steps in order to maximize the response rate and ensure an adequate sample size. In an effort to keep the survey as brief as possible and aid in the final analysis of results, there were no open-ended questions. The invitation to fill in the survey indicated that the survey would take only 10-15 minutes. The questions were designed to be answered with a minimum amount of effort and time for the respondents. The questionnaire consisted of selected-response questions with many including Likert-type rating scales for answers that ranged from strongly disagree to strongly agree as well as numerical ranking scales that ranged from 1 (least) to 5 (most). The questionnaire was worded to be as brief as possible and sought to determine the participants' opinion of the current state of WIT for construction projects in which they had been involved. The survey included questions regarding demographics, industry type, and primary occupation within their construction company.

Four industry professionals were called upon to participate in a pilot test of the survey. The test sample was asked to identify any vague or unclear wording in the document and note suggestions and performance ratings in an

evaluation form that was distributed with the test survey. The electronic Web survey was also assessed to ensure proper functionality among those who may not be completely familiar with navigating electronic surveys. At the conclusion of the pilot test, the researchers analyzed the evaluation to identify the necessary enhancement and eliminate any ambiguity from the final instrument.

A week after the launching of the survey, a follow-up reminder was sent to anyone who had not yet completed the survey. The total number of subjects who received the survey request was 298; 62 completed the survey, for a response rate of 20.8%. Anonymous Internet Protocol (IP) addresses were collected and analyzed along with the questionnaire results. It was determined that each response was unique.

FINDINGS AND ANALYSIS OF DATA

The results of the Web-based survey were compiled and exported into Microsoft Excel for formatting and charting purposes prior to using Statistical Analysis System (SAS) software to complete advanced statistical analyses. The Center for Business Analytics at BGSU was instrumental in running a series of inferential statistical analyses such as the chi-square test of independence and Fisher's exact test to investigate the relationships among the categorical variables. The confidence interval of 95% was selected, which is typical for this type of study (Devore, 2011).

Descriptive Statistical Analysis

General Contractors represented 62.9% of the respondents as shown in Table 1.

The subjects whose primary type of construction was Commercial/Industrial represented 56.5% of respondents as shown in Table 2.

Fifty-three of the 62 respondents spent the majority of their time in the office, representing the largest response rate at 85.5%. Those who spent more time in the field represented 14.5% as shown in Table 3.

Table 1. The Primary Business of the Subjects

	Response Count	Response Rate %
General Contracting	39	62.9%
Construction Management	6	9.7%
Subcontractor	6	9.7%
Other	11	17.4%
Total	62	100%

Table 2. Company's Primary Construction Focus

	Response Count	Response Rate %
Heavy/Civil	21	33.9%
Commercial/Industrial	35	56.5%
Residential/Multifamily	6	9.7%
Total	62	100%

Table 3. Majority of Time Spent in Field or Office

	Response Count	Response Rate %
Field	9	14.5%
Office	53	85.5%
Total	62	100%

Out of the 62 respondents, the majority (35) were between the ages of 36-55, which represented 56.5% of the sample population. Only 6 respondents were above the age of 56. Table 4 summarizes the response rate by age.

Table 5 presents the respondents' level of interest in tablet PCs (i.e., iPad, Galaxy, ToughBook, MS Surface, etc.) with mobile construction applications; Smartphones with mobile construction apps; cellular wireless network hardware for laptops (hotspots, wireless cards, etc.); Web-based project management software; GPS tracking software and hardware (location, speed, etc.); and RFID tags (radio frequency identification for tracking materials).

The participants were questioned on how often they accessed Web-based project management software from a wireless device. Of the 59 respondents, those who selected not at all represented the majority, with a 40.7% response rate as shown in Table 6. Thirty-four percent of the subjects used project management software from a wireless device frequently.

The next question, related to the type of business information/applications that the subjects used with a Smartphone or Tablet PC, showed that 94.7% of the respondents selected email; 49.1% and 40.4% of the respondents selected drawings and product information/ specifications, respectively as shown in Figure 1. How-to information and videos represented the lowest response rate.

Respondents were questioned regarding how many hours they spent accessing construction-related content on a smartphone or tablet PC on a weekly basis. Table 7 shows that 42.4% indicated that they spent 1-4 hours per week working on construction-related content. Figure 2 shows the percentage of the respondents who used advanced wireless technologies

Table 4. Respondent's Age

	Response Count	Response Rate %
18-35	21	33.9%
36-55	35	56.5%
56+	6	9.7%
Total	62	100%

Table 5. Level of Interest in Wireless Devices

Level of interest in	Score
Tablet PCs with mobile construction apps (i.e., iPad, Galaxy, ToughBook, etc.)	4.03
Smartphones with mobile construction apps	4.15
Cellular wireless network hardware for laptops (hotspots, wireless cards, etc.)	4.31
Web-based Project Management software	3.90
GPS Tracking Software and Hardware (Location, Speed, etc.)	3.46
RFID Tags (Radio Frequency Identification for tracking materials)	2.88

Table 6. Frequency of Accessing Project Management Software from a Wireless device

	Response Count	Response Rate %
Extremely often (multiple times per day)	10	16.9%
Very often (multiple times per week)	10	16.9%
Moderately often (a few times per month)	10	16.9%
Slightly often	5	8.6%
Not at all	24	40.7%
Total	59	100%

such as Field BIM (Building Information Modeling), a handheld wireless scanner with RFID capabilities, digital signature capture, mobile asset management (tools and equipment tracking), wireless security/alarm monitoring, and material management with RFID.

Figure 1. Types of Business Information/Applications Accessed by Respondents (*n*=57).

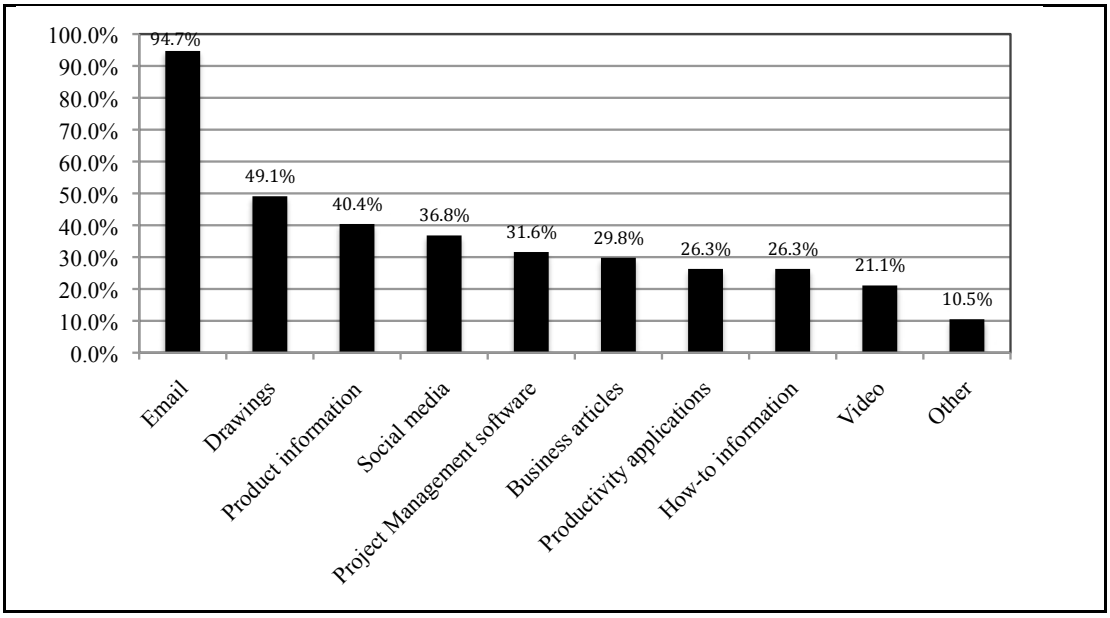
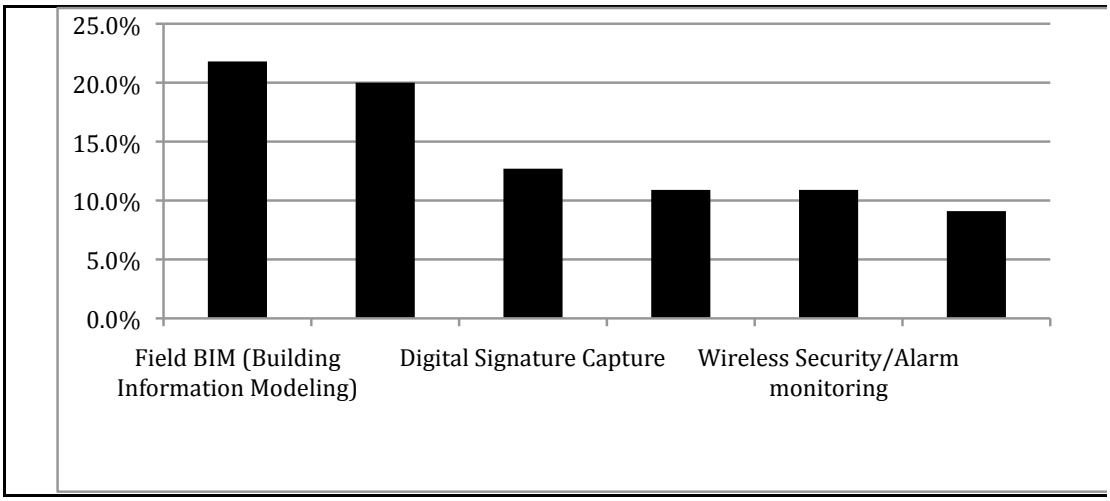


Table 7. Hours Per Week Spent on a Wireless Device

	Response Count	Response Rate %
None	11	18.6
1-4	25	42.4
5-9	14	23.7
10+	9	15.3
Total	59	100%

Figure 2. The Percentage of the Respondents Who Used Advanced Wireless Technologies



The next question sought to identify the respondents' opinion of the barriers to using wireless technology. Table 8 represents the average score on the Likert scale of their responses, which suggests that the return on investment and lack of a clean and stable environment are the main barriers, but they were not very high barriers. Please note that high cost, required training, steep learning curve, and the price of additional wireless service plans are subcomponents of the return on investment.

Table 9 shows the average score for areas of improvement caused by using a smartphone or tablet PC on a scale of one to four; it indicates that the subjects strongly agreed that their use of smartphone or tablet PC improved productivity, customer responsiveness, and collaboration. However, improving their ability to meet tight deadlines, solve problems, make decisions, manage subcontractor/ labor, manage material, manage change orders, and monitor project cost got an average score between 2.60 and 3.00.

Table 10 shows the average score in response to the question related to level of interest in construction functions for which they will use mobile devices.

Table 8. Barriers to Using Wireless Technology

Answer Options	Average score
Little return on investment	3.66
Required training	3.23
Lack of a clean and stable environment	3.23
High cost	3.19
Steep learning curve	3.14
Price of additional wireless service plans	3.05
Lack of security	3.03
High risk of breaking (durability)	2.79
Slow download speed	2.60

Table 9. Areas of Improvement Caused by Smartphone or Tablet PC

My Smartphone or Tablet PC improves my	Average score
Productivity	3.45455
Customer responsiveness	3.32727
Collaboration	3.05455
Ability to meet tight deadlines	2.94444
Problem-solving skills	2.87273
Decision making process	2.81482
Subcontractor/labor management	2.78182
Material management	2.76364
Change order management	2.64815
Ability to monitor project cost	2.6
Ability to negotiate/win projects	2.50909

Table 10. Level of Interest in Constructions for Which They Will Use Mobile Devices

Answer Options	Average Score
Daily reports	3.931034
Safety checklists	3.844828
Quality checklists	3.724138
Punch lists	3.607143
Drawing review/annotation	3.578947
RFI submission	3.464286
Submittal Review and Approval	3.22807
Timesheet tracking	3.192982

Figure 3 shows the responses regarding their expectations of purchasing wireless software or hardware in 2012 relative to 2011. The graph suggests that the highest investment is going toward smartphones, tablet PCs, and construction-related mobile applications.

Figure 4 shows the construction applications for which the subjects used smartphones or tablet PCs; they mostly used them for email, document management, and daily reports

Figure 3. Expectation to Purchase More, Less or the Same Dollar Amount of the Following Items During 2012 Versus 2011

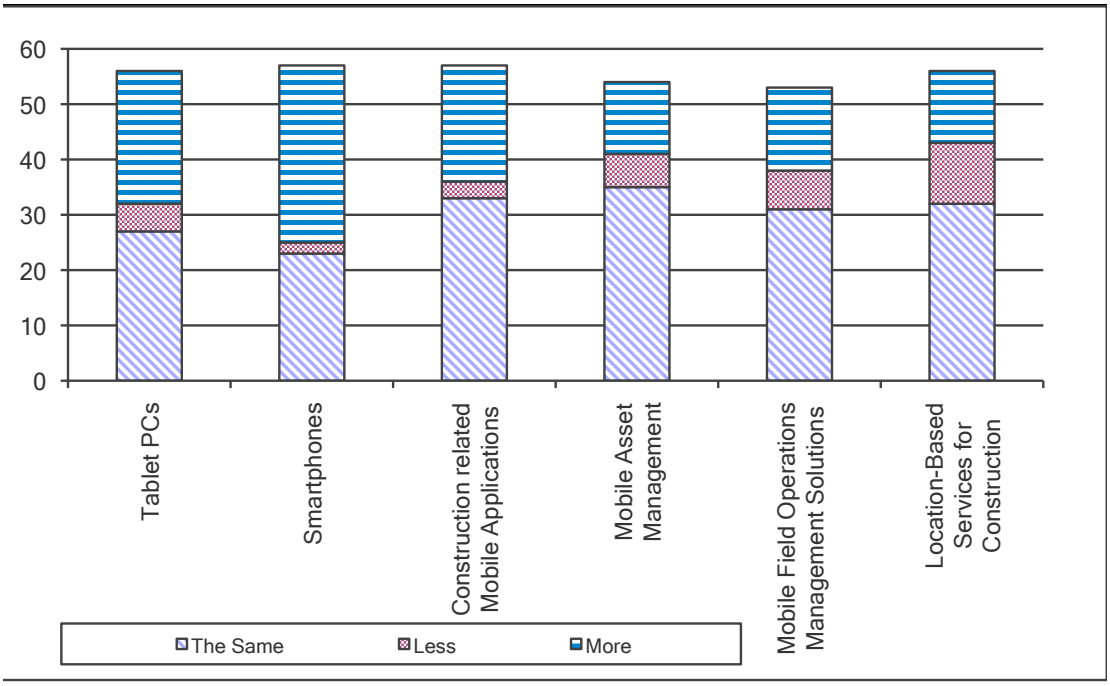
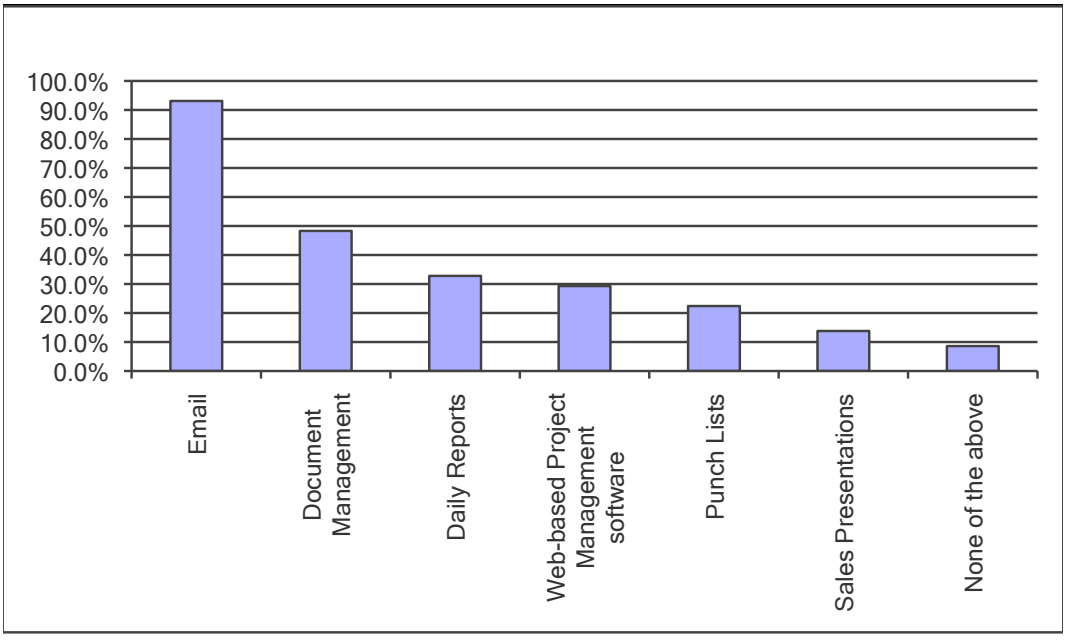


Figure 4. The Construction Applications for Which the Respondents Used a Smartphone or Tablet PC



CONCLUSION AND RECOMMENDATIONS

While interest levels among respondents were high, the results of the research study revealed several areas that should be improved before significant progress can be achieved. In summary, 72.1% of respondents indicated a high level of interest in tablet PCs, smartphones, and wireless hotspots; 59.3% of respondents indicated high interest in mobile applications that can complete daily reports, safety checklists, and quality checklists. The analysis suggests a discrepancy between the interest and usability of WPM software; 67.2% of respondents indicated a high interest in using WPM software on a wireless device, but 66.1% are only accessing project management information from wireless devices a few times per month or not at all. Wireless technology was found to enhance the skills, productivity, and customer service of the participants, but it did not improve the respondents' abilities to negotiate projects and monitor project costs.

The respondents shed some light on the barriers to wider implementation of wireless technology in the CI. Slow download speeds and durability in the rough construction environment were the largest barriers that kept people from using wireless technology. It is anticipated that the widespread use of 4G LTE and protective gear (such as ruggedized cases) will alleviate these barriers. The respondents indicated that a return on their investment in wireless technology was not a primary barrier. Interactive, online collaboration will someday be commonplace among project teams, and companies will need to create more flexible organizational roles.

The analysis of the results showed no significant difference in the level of interest among the participants whose primary business was heavy, commercial, or residential construction. However, individuals in the heavy/civil specialization reported a statistically significant higher use of mobile technology. There was not a statistically significant difference between the level of interest and use among the field and office subjects. As expected, the respondents in the age group of 18-35 used wireless technology more than the group of individuals over the age of 36; however, there was no significant difference between these groups when compared against their interest in wireless technologies. This suggests that technology interest and use is becoming less dependent upon age. As expected, the respondents who spent more time per week on their wireless device realized an improved synergistic effect on productivity and customer service skills than the group who spent less time on their wireless device.

Tablets will outsell laptops in 2013, with over 240 million units to be sold worldwide, as it is no longer the exclusive domain of Apple. Lenovo, Samsung, Toshiba, and many other leading firms introduced their own tablets. There are interesting battles brewing on whether the tablets will be powered by ARM, Intel, or AMD processors and whether the operating system will be Apple iOS, Google Android, or Microsoft Windows. These choices are good for buyers as the tablets become more optimized for specific uses such as retail point of sale (POS) or enterprise sales force tools (Ellett, 2013). Developers of WPM and other construction management software need to create a responsive design to make these programs accessible and user friendly on both tablets and PCs.

The following recommendations for future study are offered:

- This study should be repeated periodi cally to evaluate the impact of future developments in wireless technology on the CI.
- Some open-ended questions should be incorporated into a questionnaire to gain a better understanding of the motiva tions behind the answers.
- The CM departments at BGSU and other universities should adjust, if needed, the construction curriculum to prepare the students better for the future digital construction world.
- Additional survey research should be conducted on a bigger sample of re spondents that include representative of different types of construction, geo graphical locations, sales volumes, field professionals, and so forth.

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Appendix A
Survey – Current State of Wireless Technology

1. Please indicate your company's primary business?

o General Contracting	o Construction Management	o Architectural/Engineering	o Subcontractor

2. Please indicate your company's primary construction focus? (please check one)

o Heavy/Civil	o Commercial/Industrial	o Residential/Multifamily

3. Is the majority of your time spent in the field or in the office?

o Field	o Office

4. How old are you?

o 18-35	o 36-55	o 56+

5. How much interest do you have in using the following wireless technologies using a scale of 1 (least) to 5(most)? If no interest or previously unaware of the product, please check "N/A." If you already own a product, please mark "Own."

	1(least)	2	3	4	5	N/A	Own
• Tablet PCs with mobile construction apps (iPad, Galaxy, ToughBook, etc.)							
• Smartphones with mobile construction apps							
• Cellular wireless network hardware (hotspots, wireless cards, etc.)							
• Web-based Project Management software							
• GPS Tracking Software and Hardware (Location, Movement, Speed, etc.)							
• RFID tags (Radio Frequency Identification for tracking materials							

6. How often do you access web-based project management software from a wireless device?

o Extremely often (Multiple Times per day)	o Very Often (Multiple Times per week)
o Moderately Often (A few times per month)	o Slightly Often
o Not at all	o

7. What type of Business information/applications are you accessing with a Smartphone or Tablet PC? (please check all that apply)

o Email	o Web-based Project Management software
o Productivity applications	o Drawings
o Product information/specifications	o How-to information
o Video	o Business articles
o Social media (Business Purposes Only)	o Other_____

8. **How many hours/week do you spend accessing construction content on a smartphone or Tablet PC?**

o None	o 1-4	o 5-9	o 10+

9. Please indicate the severity of barriers to using Wireless Technology on a scale of 1 (is a significant barrier to use) to 5 (not a barrier at all) for each of the following:

	1(barrier)	**2**	**3**	**4**	**5(not a barrier)**
• High cost					
• High risk of breaking (durability)					
• Slow download speed					
• Steep learning curve					
• Lack of security					
• Required training					
• Little return on investment					

	1(barrier)	2	3	4	5(not a barrier)
• Lack of a clean and stable environment					
• Price of additional wireless service plans					

10. My Smartphone or Tablet PC improves my

	Strongly Agree	Agree	Disagree	Strongly Disagree
• Productivity				
• Problem-Solving skills				
• Material management				
• Subcontractor/Labor Management				
• Decision-making process				
• Ability to meet tight deadlines				
• Collaboration				
• Customer Responsiveness				
• Ability to Negotiate/Win Projects				
• Ability to Monitor project cost				
• Change Order Management				

11. During 2012, do you expect to purchase/receive more, less or the same dollar amount of the following items? (versus the same period in 2011):

	More	Less	The Same
• Tablet PCs			
• Smartphones			
• Construction related Mobile Applications			
• Mobile Asset Management			
• Mobile Field Operations Management Solutions			
• Location-Based Services for Construction			

12. On a scale of 1 (least) to 5 (most), how much interest would you have in using the following mobile apps?

	1(least)	2	3	4	5(most)
• Timesheet tracking					
• Punch Lists					
• RFI submission					
• Submittal Review and Approval					
• Daily Reports					
• Quality Checklists					
• Safety Checklists					
• Drawing Review/Annotation					

13. I have used a smartphone or Tablet PC for the following: (please check all that apply)

o Sales Presentations	o Document Management
o Email	o Web-based Project Management software
o Punch Lists	o Daily Reports
o None of the above	o

14. I have used the following advanced wireless technology (please check all that apply)

o Mobile Asset Management (tools and equipment tracking)	o Material Management with RFID
o Handheld wireless scanner with RFID capabilities	o Field BIM (Building Information Modeling)
o Wireless Security/Alarm monitoring	o Digital Signature Capture
o None of the above	o