

A Cross Sectional Study of the Uses and Application of Mobile Devices in the Construction Industry

Colin Chalupa, AC, Gregg R. Corley, MSCE, PE, and Shima I. Clarke, Ph.D., PE
Clemson University
Clemson, SC

The construction industry has historically sought to improve and adopt new technologies that help to improve communication between the construction party members. The invention of cellular technology and the devices that utilize wireless communication have drastically improved the way that industry professionals and practitioners are now able to communicate on and between the jobsite and home office. Unfortunately newer devices available to the industry present several challenges. These devices now support an array of features that while very useful, often present the users a difficult learning curve. Similarly, these devices are employed using different operating systems and therefore determining which devices support certain necessary applications and features becomes a challenge. The purpose of this study was to ascertain which mobile communication devices utilized in the industry offer the most efficient means of communication, and which support the greatest array of construction applications and software. In order to accomplish this, a survey was conducted using industry professionals and practitioners who have experience working with mobile communication devices.

Keywords: Mobile Communication Devices, Construction Industry, Construction Technology, Project Communication

Introduction

A considerable amount of the work day on any given construction project requires constant communication between all the individuals necessary to successfully complete a project on schedule and under budget. Communication is important, and the need to be in touch with the jobsite, the home office, the owner, suppliers, subcontractors, engineers, architects, and others is vital to the project success. Communications technology makes it possible to do maintain contact more simply, effectively, and economically (Sitek, 2008).

Traditionally two-way radios were the norm for establishing communication between employees on the jobsite and those located in the home office (Sitek, 2008); however, these early versions of wireless communication devices broadcasted potentially proprietary information over public airwaves, limited communication to those employees within the company who were provided with the radios, and those carrying the devices had to endure constant conversations between colleagues (Whitemore, 2008). Inevitably this was a cause of great frustration, and as a result caused the affected employee to be less efficient and productive.

The solution to such problems was primarily solved with the invention of cellular technology. These mobile cellular devices allowed secured calls between the construction team members, provided a screen to display graphics, and are also able to host an array of data and communication applications. Whether using a Pocket PC, a BlackBerry, or other type of PDA (Personal Digital Assistant), mobile communication devices can give access to the internet, e-mails, schedules, contacts, and more all from a single device, as if you were in the office (Sitek, 2008). Unfortunately, the mobile networks, hardware, and application support among the number of manufacturers of these mobile communication devices is not universal. Competition among network providers and manufacturers continue to increase to accommodate the numerous mobile communication devices that are manufactured today. Add the different systems used in different countries and the results are frustration and burnout among the users in the construction industry who have to decide which mobile communication devices and technologies to adopt (Chang, 2008).

Statement of Problem

The purpose of this research study is to assess the effectiveness of mobile communication devices being employed by industry professionals and practitioners in performing job-related duties

Research Objectives

The fundamental goal of this research was to ascertain which mobile communication devices the construction industry is currently utilizing, and more specifically to determine which devices allow their users to be most efficient and productive on the jobsite. The advantages and disadvantages of the available mobile communication devices were investigated, and were measured to determine which mobile device, or devices, are best applicable for increasing construction worker productivity and efficiency. The sample of the study was limited to active members of AIC and AGC whose primary operations are in the Southeastern United States

Research Hypothesis

The blackberry is the best overall mobile device available to construction industry professionals and practitioners for improving communication ability, efficiency, and productivity.

Assumptions

1. This research study only concerns the mobile communication devices that respondents use other than a standard cell phone.
2. The research study did not include laptop PC's or tablet PC's as they were deemed too large for the purpose of this study.
3. The research study assumes that all survey questions will be answered correctly.

Literature Review

The availability of real time, complete information exchange with the project information is critical for decision-making in construction, as information frequently has to be transmitted to and received from the project to the home office from the field site. These mobile communication devices allow crucial messages to be sent and received in a shorter time that makes the project easier to manage (Chang, 2008). Information and communication technology, specifically wireless communications through mobile devices, is seen as a key enabler of leading edge, innovative and powerful communication solutions. Mobile communication devices such as the Smart Phone, Pocket PC, PDA, and hybrid devices such as phone-enabled PDAs, and Pocket PCs, are becoming powerful enough to replace laptop computers in the field and are being widely used for real time communication of construction project information (Kondratova, 2003). The construction industry has benefited greatly from the availability of mobile communication devices, especially when employees on the job site must communicate with other construction party members to reach a decision, access job information, get facts, or report the latest developments on and off the site.

Many challenges in today's construction industry arise from poor access to the right information, at the right time, for efficient decision-making, and from a general communication breakdown between the project participants. To be productive in today's construction industry, builders and contractors must find easier more efficient means with which to coordinate material shipments, manage their subs, meet tight deadlines, and try and make a profit (Shaughnessy, 2008). In this environment mobile communication devices are seen as the key enablers and instruments of leading edge, innovative and powerful solutions of the future (Filos, 2002). It is estimated that, through improved communication processes, mobile communication devices can bring potential time and cost savings of 10% to 20% (Rankin, 2002).

When communication devices are used in construction, they can include a variety of applications. They offer the added benefit of Internet connections allowing the user to remotely access information or data. But, the constantly evolving cell phone now offers direct Internet access with camera phones and instant messaging among other features and applications (Sitek, 2008). In addition, mobile communication devices now enable industry

professionals to access advanced spreadsheet and word processing applications. Newer mobile communication devices have now implemented Bluetooth and GPS software which have an infinite number of uses that may apply to make the construction industry more effective and efficient.

While mobile communication devices enhance overall communication on the jobsite, the relatively new technology is still prone to several disadvantages. Numerous communication devices in today's world provide more options in the way contractors communicate but also manage to create a technical headache (Chang, 2008). "With an array of communication devices available to the industry, end-users must keep up with the latest communication technologies and must read, or at least attempt to learn from, equipment user manuals that, many times, are not written for the average user (Chang, 2007)." Many of these mobile devices have high learning curves and require employees to teach themselves when their employers do not provide training. Some mobile communication devices in the field are also limited by antiquated and cumbersome interfaces. A small screen size, weak signal, short battery life, questionable durability, and the lack of universal networks and application support have presented a great inconvenience for end-users (Kondratova, 2003). Many of these disadvantages present with mobile communication devices prevent their users from communicating efficiently and reaching maximum productivity on the jobsite.

Methodology

This research study sought to answer the following three research questions:

1. Which mobile communication devices are being used in the construction industry by construction professionals and practitioners?
2. Which mobile communication devices are most effective for communication and performing job-related tasks?
3. What are the advantages and disadvantages of the mobile communication devices available to the construction industry?

Questionnaire Design

A survey instrument was developed with input from the faculty advisors to obtain information to answer these questions. Upon initial completion of the survey instrument, pilot testing was conducted within the department, specifically with faculty members who have had experience in using mobile communication devices. In addition, further pilot testing was conducted with a small sample of local construction professionals. After the completion of pilot testing, some questions were reworded to remove ambiguity or vagueness. The respondents to the survey instrument were ensured their responses would remain confidential through a confidentiality disclosure attached with the survey instrument. Respondents were also given the option of including their email to have the results forwarded to them upon completion of the study.

Population and Data Collection

An email database was compiled of 350 general contractors located in the Southeast region of the United States. The email database was compiled from membership listings found on the websites of the American Institute of Constructors and the Associated General Contractors of America. The contractors within the email database received the survey instrument via a web based medium from Survey Monkey. The responses were collected by means of a collection instrument that was provided by Survey Monkey.

Of the sample of 350 construction professionals who were emailed the survey, 47 responses were received (13% response). Of these responses, only 41 had information that was deemed usable for this study (12% response). Usable surveys were determined as those that had answered the most significant questions relating to this research study.

Data Analysis

The data collected was imported into a spreadsheet program for analysis. Using this spreadsheet software, the data was presented visually via histograms, and tables. Certain questions measuring interval data that were essential to accepting or rejecting the hypotheses had one-tail t-tests performed using data analysis software supplied with the spreadsheet software. The confidence level for significance testing was 90% with an alpha of 0.1. Only the Blackberry and the cell-phone with two-way radio capabilities had a sufficient number of respondents for statistical analysis. Respondents who selected multiple devices also were removed from statistical testing.

Findings and Results

Besides cell phones, 54.1% of the respondents use a Blackberry mobile device which has the greatest share of those currently being used, as shown in Table 1. This is followed by cell phones that have two-way radio capability at 27.0%, Palm Pilots at 16.2%, Pocket PC's at 8.1%, and the iPhone at 2.7%. Other devices not applicable to this research were used by 10.8% of the respondents. This included Tablet PC's and laptops which were deemed too large for the purpose of this study.

Table 1

Mobile Devices Used Other Than A Cell Phone

Device	Percentage
Pocket PC	8.1%
Palm Pilot	16.2%
Blackberry	54.1%
Cell phone with two-way radio	27.0%
iPhone	2.7%
Other	10.8%

Table 2 shows how the respondents are using their mobile devices at the home office or at the jobsite. Results indicate that 85.4% of respondents use their mobile devices for communication purposes. Other notable applications or features respondents used on their mobile device are work-related email at 61.0%, contacts at 78.0%, text messaging at 53.7%, internet access at 56.1%, calculator at 53.7%, the calendar/planner function at 65.9%, and digital camera at 39.0%.

Table 2

Applications used on the respondent's mobile device at work by %

Applications	Percentage
Communication	85.4%
Work-related email	61.0%
Contacts	78.0%
Text messaging	53.7%
Internet	56.1%
Memos	22.0%
Letters	4.9%
Jobsite notes	29.3%
Spreadsheets	14.6%
Estimating	12.2%
Calculator	53.7%
Cost coding	4.9%
GPS	9.8%

Calendar / Planner	65.9%
Digital Camera	39.0%
Other	4.9%

Signal strength and battery life were the two most critical characteristics considered when selecting a mobile communication device. These characteristics were followed closely by the durability and price of the device, as shown in Figure 1.

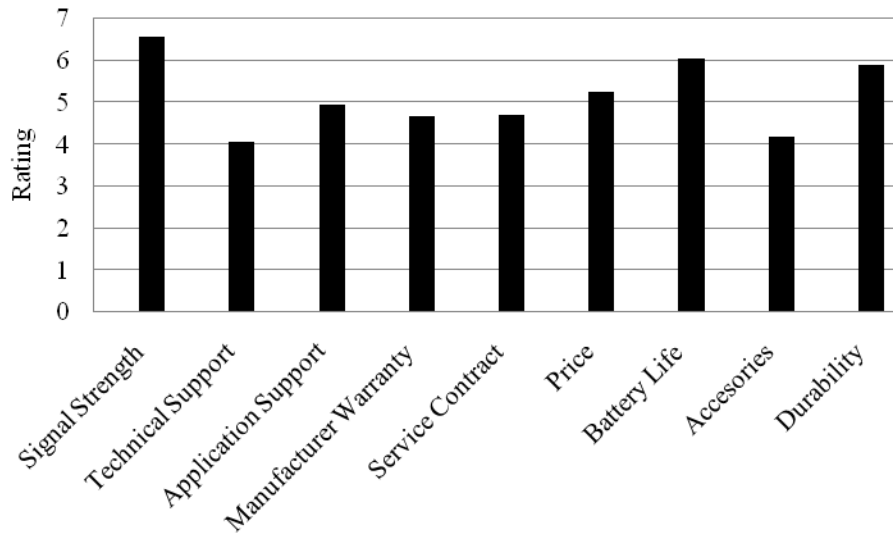


Figure 1: Importance of characteristics when selecting a mobile device (1=Very Unimportant, 7=Very Important).

Respondents stated that in terms of importance, improving communication between the job site and the home office was the best advantage of owning a mobile communication device with an average rating of 2.07. The device's ability to access job-related information quicker was second, followed by their ability to reduce job-related travel time, with recording job-site data being the least important feature with a rating of 3.34, as shown in Figure 2.

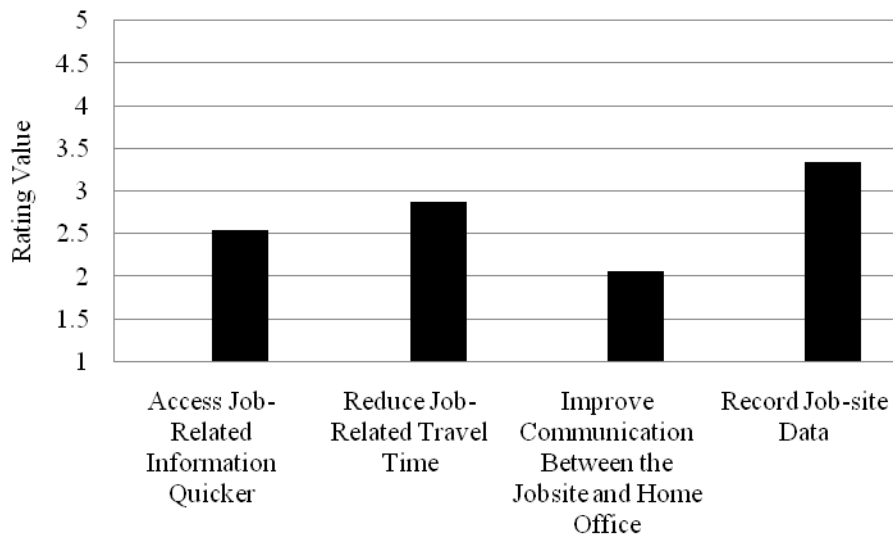


Figure 2: "The mobile device I use allows me to" (1 = Most Important , 5 = Least Important)

The most difficult problems or disadvantages experienced by the respondents in regards to the use of their mobile communication devices included the lack of battery life at 57.9% and poor signal strength at 68.4%. Small screens supplied with the mobile communication devices were an issue with 28.9% of respondents. Poor technical support and a high learning curve were problems experienced with 5.3% of respondents. Other problems such as lack of hearing audio and durability was experienced with the 7.9% of the respondents, as shown in Figure 3.

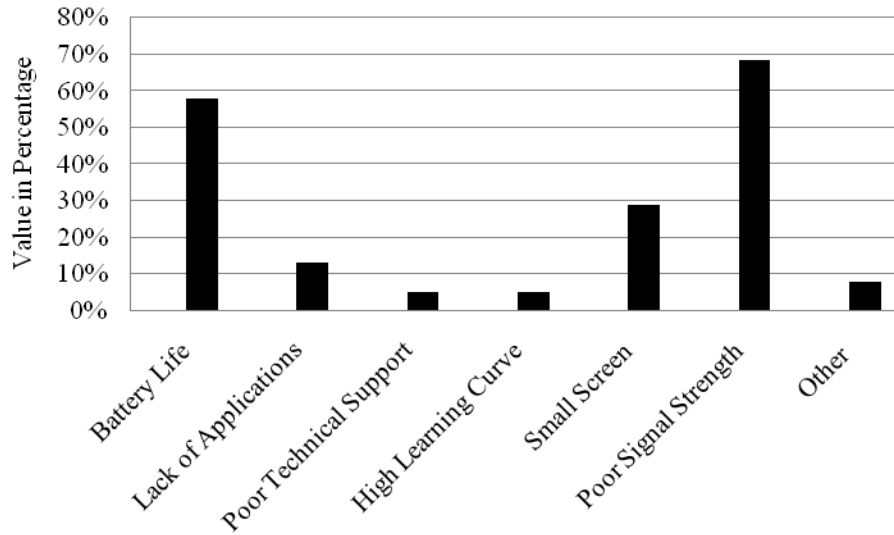


Figure 3: Most difficult problems experienced with the mobile devices by percentage

Using t-Test for two samples assuming equal variance, the Blackberry had a significant advantage over the other devices' abilities to "access job-related information quicker" over the other mobile communication devices used by the respondents. The Blackberry did not have a significant advantage with "reducing job-related travel time", "improving communication between the jobsite and home office", and "recording jobsite data" when statistically compared with the other mobile communication devices.

Advantages and Disadvantages of the Mobile Communication Devices Available to the Construction Industry

Advantages

The main advantage of the mobile communication devices currently available to the construction industry are their ability to provide improved communication means between the construction party members. Devices like the Blackberry are expanding their application support and now feature the ability to send email wirelessly, establish contacts, text message, access the internet, write letters, memos, and take jobsite notes with its built-in word processor, create spreadsheets for estimating and cost coding, access GPS software, and can take pictures with its built-in digital camera. Such features and applications allow construction professionals to do more work-related tasks outside the office than ever before.

Disadvantages

While mobile communication devices continue to improve their application support and add features, many of these devices still have critical issues that come down to the hardware. Respondents argue that many of the devices have poor battery life meaning a cell phone charger must always be nearby. In addition poor signal strength is making communication difficult for the respondents and some have been forced to carry a "backup" device as a result. Current generation of mobile communication devices are also plagued by small screens, a lack of project management application support, a high learning curve, and poor technical support.

Recommendations

It is imperative that sufficient comparison research be done when deciding to purchase a device or when employers decide to equip their employees with mobile communication devices. Because 90% of mobile communication devices are provided to employees by their employers it becomes critical for the employer to be knowledgeable of the equipment they are supplying. The employer is essentially risking their employee's productivity and efficiency at work with their decisions. Comparisons should be conducted for battery duration, signal strength in area, and price. Providing inadequate mobile devices causes loss of time and frustration which is detrimental to productivity. Employers should also increase the amount of training hours provided to the employee for working with their mobile communication device. This ensures that once in the field they can achieve maximum productivity from their mobile device which translates to productivity on the jobsite or in the home office. Individuals looking for a device that provides instantaneous communication and basic cell phone features should look into a cell-phone with two-way radio capabilities. Those looking for a device to support the greatest array of applications and word-processing features should consider purchasing a Blackberry.

Conclusions

The mobile communication device predominantly being used in the construction industry is the Blackberry. This may be attributed to the fact that the industry believes the Blackberry is better capable for work-related email and supports more applications and features. The second most used device is the cell phones with two-way radio compatibility and may result from their lower cost and easier learning curve. While not able to support an array of applications and features like the Blackberry, cell phones with two-way radio compatibility are an excellent means of providing instant communication between the jobsite and home office for the respondents using those devices.

Statistical testing determined that the Blackberry did not have a significant advantage over the other the mobile communication devices utilized by the respondents. The only category where it had a statistical significance was "recording job site data". The cell-phone with two-way radio capability had a significant statistical advantage over the other devices respondents used in "accessing job-related information quicker", "reducing job-related travel time", and "improving communication between the jobsite and home office". As a result the research study concludes that the Blackberry is not the best device available for improving worker communication, productivity, and efficiency. While not able to record jobsite data as well as the Blackberry, cell-phones with two way radio capability can provide instantaneous communication between construction party members which becomes a critical feature to construction professionals on and off the jobsite.

References

- Chang, I. (2008, March 11). *Communications Increases Construction Productivity*. [WWW document]. URL <http://www.acppubs.com/article/CA6408343.html>.
- Filos E. (2002). European collaborative R&D projects related to the "Smart organization". A first evaluation of activities and implications for construction, *Proceedings of the Conference on eWork and eBusiness in AEC*, Turk and Scherer (eds), Swets and Zietlinger, Lisse, 27-32.
- Kondratova I.L. (2003). Voice and multimodal access to AEC project information, *Mobile Computing in Architectural, Engineering and Construction, 10th ISPE International Conference on Concurrent Engineering: The Vision for Future Generation in Research and Applications, Advanced Design, Production and Management Systems* (J. Cha et al, editors), AA. Balkema Publishers, Lisse, Portugal, 755-760.
- Rankin J. (2002). Information mobility for the construction industry, *Integrated Technologies for Construction*, Canadian Civil Engineer Spring issue, 2002.

Shaughnessy, T. (2008, March 11). *Wireless Technology on the Construction Site*. [WWW document]. URL <http://www.acppubs.com/article/CA6499519.html?q=technology>.

Sitek, G. (2008, March 11). *Advances in Construction Technology*. [WWW document]. URL <http://www.acppubs.com/article/CA6459753.html?q=technology>.

Sitek, G. (2008, March 11). *Communications Going Wireless*. [WWW document]. URL <http://www.acppubs.com/article/CA6406393.html?q=mobile+technology>.

Sitek, G. (2008, March 11). *Communications in Construction*. [WWW document]. URL <http://www.acppubs.com/article/CA473342.html?q=PDA>.

Whitmore, R. (2008, March 11). *Wireless Solves Contractor's Communication Needs*. [WWW document]. URL <http://www.acppubs.com/article/CA6497855.html?q=mobile+technology>.