Construction Apps: A Critical Review and Analysis

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ABSTRACT

At the end of 2013 it is estimated that there are nearly 13,000 apps related to design and construction available on Apple's iPad. With this many apps available in the market finding the right app for a construction manager can be a challenge. The purpose of this research was to identify mobile apps that can be used in the life cycle of a construction project. A total of 205 design, construction, and facility management apps were recorded. The majority of mobile apps discovered were apps to be used during the construction phase of a project. Research revealed there is a lack of mobile apps for facility management in the market. Apple's iOS platform was found to be the most popular operating system followed by Android with Windows 8/8.1 being the least popular platform. This research also aimed to discover the top ten best apps for a construction manager. Construction managers from several different companies were interviewed to find out what apps are currently being used in construction as well as which activities mobile apps would be most useful. It was discovered the majority of apps currently used by construction managers are not construction apps. Interviewees also indicated apps would be most useful for activities related to quality control, specifically deficiency tracking. Another goal of this research was to explore current and future challenges of implementing apps in the construction industry. The top two problems identified were (1) lack of training and (2) difficulty viewing documents on mobile devices. This suggests companies could improve the use of mobile apps by properly training employees.

Keywords

Mobile Technologies, Apps, Smart Phone, Tablet, Project Management

1 Introduction

Tablets and many other mobile devices are now used as tools in the majority of businesses [1]. This includes the construction industry. The question has shifted from "will" tablets be used to "how" tablets will be used in construction [2]. Currently there are many apps available in the market that can be used in construction for activities such as quality control, safety, and marking up plans in the field. However, finding the right mobile application (or App) for designers, estimators, schedulers, construction managers and other construction professionals can be challenging. Currently neither Apple's App store nor Google's 'GooglePlay' app store have categories to help professionals find the Apps they need [2]. Thus, finding an App for a particular need amongst the thousands of apps available can be cumbersome.

The purpose of this study is to discover the Apps available in the market that can be used in the life cycle of a construction project. One of the questions this study aims to answer is: what apps are best suited for a construction manager? This research will examine those Apps currently used by construction professionals via semi-structured interviews. After identifying popular Apps, these Apps will be reviewed based on a set of criteria such as ease of use and effectiveness. This research will also aim to explore the current and future challenges of implementing apps in the construction industry.

2 Literature Review

The literature review for this paper included an investigation of the historical aspects of apps in the construction industry, a review of current trends in the usage of construction apps and a consideration of mobile devices available for use in the construction industry.

2.1 Historical Perspective

The construction industry has often been chided for being late adopters of technological innovations in the field, but tablets have the potential to change all that [1]. Apple introduced the first smartphone in 2007 [3]. However it was not until January of 2010 that Apple introduced the first tablet. Since then other companies have produced their own smart devices that support other platforms such as Android and Windows 8 to

compete with Apples IOS operating platform. At the end of 2013, three years after the first tablet was released, it is estimated that there are nearly 13,000 apps related to design and construction available on Apples iPad [4]. This is a significant increase to the 230 design and construction apps available in 2011 [3]. Android tablets have their own list of applications which are being developed at a faster pace Apples iPad apps and without as many proprietary problems as all Apple apps are required to be Apple certified before they are available for general public use [5].

Two of the main benefits of mobile devices being used in the construction field are time and cost savings [6]. The construction industry is an information-intensive industry where the success of a construction project depends on the availability of accurate and timely data [7]. Current methods of exchanging information on the construction site are labor intensive and require manual intervention resulting in a delay of information exchange [7]. There are many apps available that allow construction professionals access everything they need in the field without carrying around spec sheets and drawings [8].

Van Hampton [1] notes that although this technology is being widely used in many businesses, "most companies lack a clear strategy for mobile computing and experience training lags." According to Abaffy [6] some companies are waiting to use mobile technology on the jobsite until IT support within the organization is in place. Companies must decide who will train users and provide technical support. Some apps in the market include training and technical support while others do not. Therefore, companies are considering providing in house tech support to help train employees in the field in addition to support offered by software developers [6].

2.2 Current Trends in Construction Apps

Information about popular construction applications for tablets and mobile devices was published by industry trade magazines such as Engineering News Record (ENR), based on reader surveys. A compilation of these findings is presented in Table 1 of this section. The apps themselves are categorized based on their functionality into 'General Office Productivity', 'Construction Drawings & Document', '3D Visualization / Drawings' and 'Construction Calculations'. It must be noted some of these apps have additional capabilities to be listed as crossover apps between the categories listed in Table 1.

Table 1: Popular Construction Apps (Compiled from [9], [2] and [10]

Categories	Apps
General Office Productivity	• Ustream Broadcaster • Prontoforms • Toodledo • Punch List • Crane-Operator Hand Signals • OSHA Heat and Safety Tool • Dropbox • Good Reader • Evernote • eWeather • OSHA Heat Index
Construction Documents & Drawings	• On Site Planroom • Control Center 7 • Bluebeam Revu • Tracing Paper Lite
3D Visualization / Drawings	• BIMX • TurboViewer • Autodesk Sketch Book Express/Pro • Autodesk BIM 360 Field
Construction Calculations	• Home Builder Pro-Calcs • My Measures & Dimensions • Drywall Calculator • My Dimensions Pro • Decibel Ultra Pro

The compilation of apps used according to various industry sources suggests that the use of mobile construction apps is on the upswing. Furthermore, it must be noted that since the publication of the articles used to compile the list in Table 1, several more apps have been introduced in the market place.

2.3 Mobile Devices in the Construction Industry

Researchers have been exploring the use of mobile devices in the construction industry. According to Chen

et al. [11], mobile computing includes three major components: mobile computers (hardware), wireless networks, and mobile applications. The framework they developed sets forth a process for selecting the optimal mobile computing strategy for a project using an application model. The application model is based on dependent factors and independent factors. The dependent factors include mobile computer, wireless network and mobile application. The independent factors include the end user, the construction site and construction information. Each of the three independent factors are based on the specific construction project and are used to define the dependent factors.

According to Kim et al. [12], research on mobile computing for construction can be classified into five separate areas as follows: 1) development of a framework to determine how mobile computing should be used for construction; 2) using mobile computing as a tool for construction management; 3) mobile computing for deficiency tracking; 4) mobile computing for managing safety or disaster response; 5) development of specific mobile computing features.

Son et al. [7], investigated factors that influence the acceptance of mobile computing in the construction industry. In their study Son et al. [7] used user satisfaction as a measurement of success and studied the effects of perceived usefulness and perceived ease of use on user satisfaction. The study concluded that user satisfaction is an important indicator of the successful adoption of mobile computing devices in the construction industry. The study also concluded that acceptance of mobile computing devices by construction professionals is more likely affected by perceived usefulness rather than perceived ease of use. Existing research [7] points to mobile device applications as useful tools that can be used on the construction jobsite.

3 Research Methodology

The methodology for this research used both a qualitative and quantitative approaches. The qualitative methods used include interviews with project managers, superintendents, and quality control managers with three construction companies that actively use mobile technology. A total of seven interviews were conducted as part of the qualitative data collection process. Participants were interviewed using the semi-structured interview approach to determine construction apps usage by professionals, as well as to discuss current and future challenges to using apps in the construction industry. As mentioned earlier, Son et.al [7] discovered a person's perceived usefulness of a mobile device was more important than their perceived ease of use. Therefore the questions presented during the interview have been constructed to determine a person's perceived usefulness of an app.

Extensive research on available apps from Apple's app store, Google's GooglePlay store and Windows app store was conducted in the quantitative approaches used in this study. The average rating for each app was collected from each of the app stores, including for apps which were available on multiple platforms. Interview participants were asked to rate the apps they used to determine their perceived usefulness. The ratings gathered from the interviews and the app store ratings were used to rank the top 10 apps. It must be noted that this methodology provides a snap-shot view of app ratings and cannot be considered with any sense of permanency.

4 Results

A description of the collected to conduct this research is discussed in this section. The findings are described within the quantitative and qualitative types of data collected for this research. A list of top 20 apps used by construction professionals based on the ratings from app stores and interview data of construction professionals is also presented.

4.1 Quantitative Data

The data gathered from the app stores indicated that a number of construction related apps are available for use. A total of 205 apps were found across all app stores. The majority of apps recorded (83%) operate on the iOS platform whereas (32%) were based on the Android platform and only (0.03%) use the Windows 8/8.1 operating system. The number of apps recorded for each operating system is provided below in Table 2. It must be noted that data represents a snapshot view of the apps available and that this is constantly changing as new apps become available.

Table 2: Number of Apps Recorded Per Platform

Operating Platform	Number of Apps
Apple	171
Android	65
Windows	6
Total	205

Table 3 contains a list of primary categories and sub-categories used to classify each app. These categories were determined based on the apps description. The number of apps found across all platforms were counted and are presented within the parenthesis of the subcategories described in Table 3. Three main categories of apps were discovered: Information, Productivity, and Calculation Tools. Information apps are those which the primary function of the app is to supply information on a specific topic. Productivity

apps are those apps whose primary function is information management. These apps perform such functions as preparing documents, managing task, or editing documents. A third category of apps noted was calculation tools which included various calculators and another app that allow a person to use their mobile device as a level.

Table 3: Primary and Sub Categories for Mobile Apps

Primary Categories	Sub Categories
Information	Safety (12) News (5) Construction Code (17) Sustainability (9) Equations (17) Product Data (6) Cost Information (1) Claims (1) Specifications(3)
Productivity	Facility Management (2) Claims (1) Estimating (12) Change Order (1) BIM (7) Bid Management (1) Contract Maker (1) Quality Control (5) CAD (9) Document Viewer (10) Project Management (4) Video (3)
Calculation Tools	Calculator (75) Measuring (2) Level (2)
Cloud Storage	Information Sharing (10)

Within the sub-categories, the data revealed that by far the number one type of apps available at the time of this research were created for calculation purposes (75). Apps for construction codes (17) and construction equations (17) were tied for second and safety (12) related apps were third among the sub-categories of available apps.

Apps were also broadly categorized based on their usage at the any given lifecycle stage of the project and are listed in Table 4. The data revealed that the largest (78%) number of apps available were for construction purposes, followed by apps for design professionals (30%) and lastly for facility managers (12%). It must be noted that some apps were capable of being used at multiple phases of the life cycle of a project.

Table 4: Total Apps for Each Life Cycle Phase

Design	63
Construction	160
Facility Management	24

4.2 Qualitative Interview Data

Respondents listed a total of 21 specific apps shown in Table 5. Of the 21 apps listed only 4 (19%) of the apps were included in the list of construction apps provided in Table 1. This suggest that the majority of apps being used by construction companies are not construction apps. The most common app specified by name by interviewees was Drop Box which is a file sharing app. Among the apps listed in the interviewees included construction specific apps such as BIM 360 Field, BIM 360 Glue, Trimble, Safety Net, Prolog, Trimble, Sketchup and Revit. Another group of apps reported by interviewees was weather apps such as 'Intellicast' and 'Weather'. A large number of general purpose apps were also listed by the interviewees including 'Concur' (expense keeping app), PDF Viewer, Genius Scan, Bluebeam, Ox Blue, Outlook, Sharepoint, Goto and Prezi. This further supports the idea that the majority of apps in use by construction companies are not specialized construction apps.

Table 5: Mobile Apps listed by Interviewees

Safety Net, Prolog, Intellicast, BIM 360 Field, BIM 360 Glue, Trimble, Concur, Drop Box, Bluebeam, Revit, Sketchup, Predictive Solutions, Ox Blue, Outlook, Prezi, Goto, Sharepoint, GoodReader, Weather, Camera, Calculator, PDF Viewer, Genius Scan

Interviewees were asked about the type of apps most used and the themes that were commonly repeated included 'Viewing Documents', 'Weather Related Apps', 'Information Sharing Apps', 'Safety Apps' and 'Quality Control Apps'.

4.2.1 Perceived Usefulness

Participants were asked about how they perceive the usefulness of an app, given a particular theme. The results were used to calculate a perceived usefulness score based on the number of respondents who cited a particular theme. The formula used to determine the score is listed Table 6.

Table 6: Perceived Usefulness Calculation

Perceived Usefulness Score = (# of Occurrences) * 5/7

Since the app rating from the app store are based on a value of 0 to 5 each theme was assigned a perceived

usefulness score based on a 5 point value. This was done so that each factor, the perceived usefulness score and app rating form the app stores, would be equally weighted when entered into the matrix to determine the apps overall score. In order to calculate the score for each app the total number of occurrences of an individual theme was divided by the maximum number of occurrences of all themes and then multiplied by a factor of 5. The Apps that did not fall into any of the categories listed above were given a score of 0.

Table 7: Perceived Usefulness Score

Theme	Perceived Usefulness Score
Quality Control	5.0
Document Viewing	2.9
Safety	1.4
Monitoring Weather	0.7
Sustainability	0.7
Sharing Information	0.7

Results presented in Table 7 indicate that construction professionals believe apps would be most useful for quality control activities. The most popular quality control activity mentioned by all interviewees was deficiency tracking. All of the interviewees believed using apps to track deficiencies in the field would prove to be very useful. The second most useful activity reported was document viewing in the field. One type of app that none of the interviewees listed as useful was calculator based apps.

4.2.2 App Ranking

In order to determine the best apps for a construction manager, the app's rating from the app store, and the app's perceived usefulness score based on the sub-category of the interview results, was combined into a matrix to determine an overall score for each app. Apps were then ranked based on total score.

The top 10 construction apps found based on the proposed matrix are presented in Table 8. It must be noted that the results from the qualitative and quantitative data were used to determine the top ten list. The rating found that Tradie's App was the highest rated app for construction managers. Tradie's App is a general purpose field documentation and information access app. The app allows users to record change orders, keep meeting minutes, keep a site dairy, record purchase orders, access estimates, schedule etc.

Table 8: Top 10 Construction Apps

	Name	AR	PS	TS
1.	Tradie's App	4.55	5	9.6
2.	Procore for iPhone	4.5	5	9.5
3.	Onsite Punchlist	4	5	9.0
4.	Plan Grid	5	2.9	7.9
5.	OnSite Files	4.5	2.9	7.4
6.	Aconex Mobile	4.25	2.9	7.2
7.	OnSite Photo	4.25	2.9	7.2
8.	PunchIt	2.1	5	7.1
9.	Foreman's Mate	2	5	7.0
10.	Drawvis	4	2.9	6.9

AR = Average App Rating from app stores
PS = Perceived Usefulness Score
TS = Total Score

Most of the apps listed in Table 8 are directly related to the duties of a construction manager. Similar to Tradie's App, the remaining top 10 construction apps assist the project manager / site superintendent in performing their daily duties.

4.2.3 Potential Problems to App Usage

Interview participants were asked to discuss any potential problems they thought would hinder the usage of construction apps. The themes commonly occurring among the interviewees are presented in Table 9. Issues related to security, training, difficulty in viewing the app and poor performance of the app were found to be the most concerning to the interviewees.

Table 9: Potential Problems to Construction App Usage

Common Themes
Security
Lack of training
Difficulty viewing
Poor performance

Literature review also showed that many companies lack a clear strategy for implementing mobile devices and are waiting to use mobile devices in the field until an IT Support system is in place. Interviewees seemed to confirm the findings in the literature about the lack of an overall strategy for implementing mobile device apps in construction organizations. Based on information gathered during the literature review and the interviews it is clear companies need to devise a strategy for supporting employees using mobile devices in the field.

4.3 Summary of Main Findings

A summary of the main findings of the qualitative and quantitative data analysis is listed below:

1. Apple's iOS was found to be the most common operating system for construction apps.
2. There are very few construction apps for devices using the Windows 8/8.1 platform.
3. There are very few apps available for facility managers to use during the operation and maintenance phase of a project.
4. The majority of apps currently used by construction managers are not construction apps.
5. The most common activity mobile apps are being used for in construction is document viewing followed by sharing information and monitoring the weather.
6. Construction managers believe apps would be most useful for quality control activities.
7. Apps used a calculation tools were believed to be the least useful by construction managers.
8. A lack of training and trouble viewing documents on mobile devices were the most common problems reported.

5 Conclusions and Recommendations

A total of 205 design, construction and facility management apps were discovered during this research. The most popular operating platform was Apple's iOS with (83%) of the listed apps operating on this platform. Research shows that there are very few Windows 8/8.1 construction apps available. This is consistent with information provided in the literature review. The majority of apps discovered were construction apps to be used during the construction of facilities. Despite the numerous construction apps available on the market research indicates the majority of apps used by construction professionals are not construction apps. Based on interviews the most popular apps were cloud based storage apps. The apps are being used to share large files between construction teams in the field. The second most popular type of app currently being used by construction professionals are weather apps. These apps are being used to schedule and coordinate weather sensitive construction activities. Construction professionals indicated apps would be the most useful when used to conduct quality control activities. Specifically quality control activities related to tracking deficiencies. Another popular use discovered was viewing documents in the field. All of the top ten apps listed above for construction managers are directly related to quality control activities. There are a number of calculator based apps available on the market. However, it was found these types of apps are of little use to construction managers. Research also revealed that a lack of training is be thought to be major problem with the use of apps in the field. While many companies provide their employees with mobile devices in the field, whether smart phones or tablets, companies do not provide the necessary training to their employees to effectively use the apps. Any training, whether provided by the company in house or by software developers, would increase the use of mobile apps in construction. Another major problem reported when using apps was difficulty viewing information on the mobile device's screen. Considering mobile apps would be best used for quality control and viewing documents electronically in the field it is important companies consider screen size when deciding which mobile devices to use on the construction site.

Recommendations for future actions to improve the use of construction mobile apps include:

1. Research should be conducted to evaluate the performance of the top ten apps for construction managers listed above.
2. Companies that provide mobile devices to their employees in the field should develop a training program for employees. When developing a training program companies should weight the benefit of providing in-house training or hiring software developers for training courses.
3. Since screen size is important for using quality control based apps research should be done to determine the best mobile devices for field personnel.
4. Since very few facility management mobile apps were discovered research should be conducted with facility managers to determine what types of apps are currently being used by or would be useful for facility managers.

6 References

[1] Van Hampton, T. (2011). Tablets Take Off. (Cover story). ENR: Engineering News-Record, 267(7), 20–23.

[2] Joyce, E. (2011). ENR's Top 10 Construction Apps. (Cover story). ENR: Engineering News-Record, 267(16), 31–31.

[3] Arthur, C. (2012, January 24). The history of smartphones: timeline. The Guardian. Retrieved from http://www.theguardian.com/technology/2012/jan/24/smartphones-timeline

[4] Yovino, J. (2012, December 28). 13 construction apps for 2013. The Daily Reporter - WI

Construction News & Bids. Retrieved from http://dailyreporter.com/2012/12/28/13-construction-apps-for-2013/

[5] M. H. Goadrich and M. P. Rogers, “Smart Smartphone Development: IOS Versus Android,” in Proceedings of the 42Nd ACM Technical Symposium on Computer Science Education, New York, NY, USA, 2011, pp. 607–612.

[6] Abaffy, L. (2011). iPads and Tablets: Time Saved Vs. Time Spent. ENR: Engineering News-Record, 267(9), 20–20.

[7] Son, H., Park, Y., Kim, C., & Chou, J.-S. (2012). Toward an understanding of construction professionals’ acceptance of mobile computing devices in South Korea: An extension of the technology acceptance model. Automation in Construction, 28, 82–90. doi:10.1016/j.autcon.2012.07.002

[8] Q&A: State of the Slate. (Cover story). (2011). ENR: Engineering News-Record, 267(7), 23–23.

[9] ENR, “Most Recommended Apps ENR 2013,” 2013. http://enr.construction.com/engineering/pdf/ENR03252013NWS_Survey_apps.pdf

[10] Abaffy, L. (2011). Nine Noteworthy Apps for Construction. ENR: Engineering News-Record, 267(7), 19–19.

[11] Chen, Y., & Kamara, J. M. (2011). A framework for using mobile computing for information management on construction sites. Automation in Construction, 20(7), 776–788. doi:10.1016/j.autcon.2011.01.002

[12] Kim, C., Park, T., Lim, H., & Kim, H. (2013). On-site construction management using mobile computing technology. Automation in Construction, 35, 415–423. doi:10.1016/j.autcon.2013.05.027