

MOBILE APPLICATIONS FOR THE CONSTRUCTION INDUSTRY

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The construction industry has been criticized as an “old-school” industry, because of being a slow adopter of mobile technologies. This has changed recently. A 2014 survey of 1,048 participants found that 72% of construction practitioners have smartphones, and use smartphone applications for work purposes. While there are thousands of smartphone applications advertised as “construction apps”, the most popular smartphone applications offered by software providers to the construction industry are for field data collection, project management, bidding, building information modeling (BIM), accounting, customer relationship management, and estimating. This paper discusses the current state of smartphone applications available to the construction industry, and examines the apps’ functions. Due to the rapid growth in the smartphone applications market, new applications become available every day for use in different industries. Given the large number of choices, both companies and individuals in the construction industry must beware when selecting and purchasing smartphone applications. The business needs of the potential users and the expectations from the applications must be well identified, and the selection must be made accordingly. Properly selecting and deploying smartphone applications for construction-related tasks is expected to improve communication, enhance workflow with real time information, and increase productivity.

Keywords: Mobile apps, Smartphone apps, Construction tasks, Computerization, Construction productivity.

1 INTRODUCTION

Smartphones and mobile applications that run on them have changed the world and have become a part of everyday life. As of July 2015, the total number of mobile applications available in leading mobile application stores (e.g., Google Play, Apple App Store, Amazon Appstore, Windows Phone Store, and BlackBerry World) is almost four million. The applications cover many fields and can execute a variety of tasks, but they have one main purpose, and that is to deliver a service (Krouse 2012).

According to *Engineering News Record* (ENR) (2011), mobile devices are also changing construction management. Construction professionals use tablets and smartphones to increase job-site efficiency. Both tablets and smartphones combine mobile accessibility with mobile construction management applications, with the added advantage for smartphones that they can fit in a pocket and provide the same benefits.

The main advantage gained from the use of such mobile devices is that they enable construction professionals to work interactively and dynamically; data collected from the site is shared in real time among the project participants with visual attachments, and site reports are generated with more accurate and up-to-date information.

It is apparent that construction companies need to go mobile in order to stay competitive in the industry. However, it is essential to establish a mobile device strategy before selecting a mobile device and applications. Since carrying multiple devices is not ideal for construction professionals, the selected applications must be compatible for the device used for work purposes. Different mobile devices with different operating systems limit the choice of applications. In selecting a mobile device, the advantages and disadvantages of its operating systems must be taken into consideration. For example, Apple's iOS is easy to use and learned quickly by many people, whereas no device that uses iOS has an actual keyboard. Most people are already familiar with Windows' operating system, but application support between its different versions is lacking. Android has the biggest market share, operates on many devices available in different sizes, and with native keyboards. However, Android's information security is a concern. It follows that first, companies should prioritize their business needs and expectations from mobile technologies, and then select a mobile device and applications to implement. A successful implementation requires a combination of good applications and sufficient training, regardless of the chosen device (Bulley 2013).

Chen and Kamara (2011) developed a framework to examine how mobile computing technologies can be used in construction sites to exchange on-site information. Three key issues about mobile devices, mobile applications, and wireless networks were stated in the study. First, mobile devices used on site should be equipped with the hardware that allows users to process site information effectively and efficiently. This hardware includes but is not limited to keyboard, touch screen, voice recorder, and camera. Second, mobile applications used for onsite information exchange should have specific functions for different users that have different roles in construction projects. For example, a project manager needs to review drawings, monitor progress, update schedule, and distribute records, whereas a site engineer needs to review drawings and run necessary calculations. Third, the wireless network that the mobile device uses should provide coverage for large geographic areas especially if users work on several construction projects simultaneously.

Currently, construction information exchange is done through traditional information and communication methods that are non-automatic and paper-based. However, having construction information digitalized by using a mobile computing technology that runs automatic information management activities is ideal and much desired. There are three strategies that can be implemented to improve on-site information management from the current state to the desired level; utilization of a commercially available mobile application that can be synchronized with the main information system, utilization of a commercially available mobile application that can transfer data to the main information system wirelessly, and design/development of a specific mobile application that exchanges data with the main information system wirelessly.

2 MOBILE APPLICATIONS IN THE CONSTRUCTION INDUSTRY

Lu *et al.* (2014) investigated the current state of information and communication technologies (ICT) in the architecture, engineering, and construction (AEC) industry through a review of 145 papers that were published in selected journals between 1998 and 2012. Application development was the second most popular research method in the reviewed papers after empirical analysis. Even though the use of mobile applications is gaining popularity in the construction industry, its adoption is a vital process that must be conducted properly. The study showed that there are five elements that affect adoption: the user, the organization, the technology, the project, and the environment. A successful implementation of new technologies requires training and participation of users. Top management executives' involvement in new technologies facilitates the adoption process. The technology adopted by organizations must be easy to use, compatible, reliable, and provide information security. Project type, cost, duration, specifications, and location must also be considered in selecting and adopting technologies. The environment affects the use of mobile technologies indirectly. For example, government regulations, competitive forces, market demand, vendor strategies, professional norms, current status of technologies, and socio-economic condition can affect organizational behavior in selecting and adopting new mobile technologies.

Studies of mobile applications in the construction industry can be grouped into three categories; general construction management, defect/damage management, and equipment management. This section reviews the studies conducted under these three categories.

In recent years, construction companies have become aware of the potential in using mobile applications. Some companies are developing their own mobile applications. The reason behind this shift is that a large amount of information is produced during construction, but this information is not managed efficiently. Chen (2013) claimed that two thirds of the problems encountered in construction projects is related to information and communication problems, and proposed a mobile application prototype that aims to solve these problems in construction management. Five main functions were provided within the application: contract administration, progress control, equipment management, cost control, and quality management. With the given capabilities, it was suggested that using mobile applications in construction management can minimize time-space constraints, reduce time spent in decisions making, provide real-time information, and strengthen competitive advantage.

Construction professionals with different roles require different types of information to manage the construction activities that they are responsible for. Nourbakhsh *et al.* (2012) investigated the information requirements for mobile application use in construction management. The importance of different categories of information was evaluated from the perspective of consultants, contractors, and owners. It was found that owners need information regarding delay records, site instructions, schedule updates, productivity performance, change orders, variation orders, daily reports, and QC/QA problems, whereas contractors need to access schedule updates, violation reports, QC/QA problems, accident reports, productivity information,

inspection results, progress photos, and change orders. On the other hand, consultants need design intent and clarification information. In response to these diverse needs, Nourbakhsh *et al.* (2012) developed a mobile application called Construction Mobile Application (CMA) that was evaluated by a number of construction practitioners, and was found to be efficient, user-friendly, and easy to use.

Kim *et al.* (2013) presented a mobile application for on-site management that allows construction managers and site engineers to monitor construction sites, manage activities, and exchange real-time information. The application was tested in a hospital building project to validate its usefulness. The test showed that the application has great potential to improve the overall performance of on-site management by improving the level of data sharing and communication, reducing travel time, minimizing rework, and improving quality.

Most of the information and communication related activities in the construction industry are time consuming when conducted manually. Chen *et al.* (2013) stated that it takes time to obtain an organized and complete report of visual inspection of damaged structures because engineers capture photos and gather information on site individually, and because the detection and quantification of the damage is measured through cumbersome manual approaches. Chen *et al.* (2013) developed a mobile application called Collaborative Mobile-Cloud Computing (CMCC) to improve the current practice in team-based visual inspection of civil structures. In a field based experiment, it was found that CMCC can be used for post-disaster and routine inspection of civil structures in an environment that requires collaboration, imaging, and real time information. In a parallel effort, Walker *et al.* (2013) developed a mobile application called Mobile Information Collection Application (MICA) whose purpose was to provide data collection and organization support in infrastructure assessment, and to eliminate unorganized and paper-based documentation. The application was used by sixty inspection teams that investigated the Mississippi River flood in 2011. It was found that the teams that used the application operated the inspection more efficiently and effectively than other teams. The application allowed the user to capture visual data and location information and share it with the command center in almost real time. The study showed that the use of MICA saves travel hours, increases productivity and accuracy of information, and improves safety.

A smartphone provides a constant feed of information among people that interact with each other on a daily basis. Using a smartphone for work purposes is a decision that many contractors are considering today. The potential benefits of using smartphones on site outweigh the costs of user training, purchase of mobile devices and applications. One of the potential benefits is that a construction manager can monitor job-site productivity, and take necessary actions to maximize efficiency. Built-in cameras allow project participants to exchange site data with photos and videos which, in some cases, are much more detailed and informing than a conversation. Real time job site data with visual attachments can even increase a contractor's credibility with the owner. With a variety of selections, construction companies and professionals can find commercially available applications that can assist with day-to-day operations, increase productivity, credibility, and cost efficiency (Yunorich 2011).

As stated, development of a specific mobile application is not the only method that can be used to improve productivity and efficiency in the construction industry. There are several mobile applications that are commercially available and already being used by construction companies. Table 1 shows the most commonly used mobile applications in the construction industry that are commercially available in Google Play and Apple App store.

Table 1. Commercially available mobile applications for the construction industry.

Specific Use	Application Name	Platform	Cost
Bid Management	SmartBidNet	iOS	Subscription Required
BIM	Autodesk BIM360 Field	iOS	Subscription Required
	BIMx	iOS/Android	Free
CAD, Design & Drawings	CAD Touch	iOS	Free
	Finger CAD	iOS	\$5.99
	REVITKeys	iOS	\$0.99
	iRhino 3D	iOS	\$3.99
	AutoCAD 360	iOS/Android	Free
	DAKO PRO Civil Eng.	Android	\$9.99
	Rilievo	Android	\$4.08
Calculator	AndCAD	Android	\$34.99
	Construction Master Pro	iOS/Android	\$24.99
Contract Management	Contract Maker Pro	iOS	\$4.99
	Contract Maker Elite	iOS	\$19.99
Document Viewing	Drawvis	iOS	Free
	iBlueprint	iOS	\$0.99
Estimating	Quick Service Estimates	iOS	Free
	Contractors Estimating	iOS	Free
	Construction Cost Estimator	iOS	\$19.99
	Ultimate Estimator	Android	\$4.99
	A Estimate All Pro	Android	\$3.99
LEED	Leed BDC Flashcards	iOS	\$19.99
Project Management	Procore	iOS	Subscription Required
	OnSite Punchlist	iOS	Free
	Construction Manager	iOS	Free
	ArchiReport	iOS	Free
	Safety	iOS	Free
	Safety Meeting	iOS/Android	Free
Scheduling	Wrike	Android	Free
	Project Plan 365	Android	Free
	Project Planning Pro	iOS/Android	Free

The studies cited in this paper demonstrate the important role of mobile applications in the construction industry, and validate that using smartphones and mobile applications can increase productivity, efficiency and information accuracy, decrease travel time and costs due to rework.

3 CONCLUSION

The construction industry has realized the potential in using mobile devices and applications for work purposes. Several studies conducted recently validated that using smartphone applications for construction-related tasks can improve the level of communication, enhance workflow with real time information and increase productivity. There are two methods that are most commonly used in adopting mobile technologies in terms of mobile applications; development of a specific application for identified needs, and utilization of a commercially available application corresponding to the identified needs. However, regardless of the method chosen, establishing a mobile strategy is of vital importance for a successful implementation. Before making the decision of investing in a mobile application, the roles of the construction practitioners that are going to use the application must be identified and the expectations from the mobile application regarding its functions must be determined accordingly.

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