The Use of Mobile Construction Applications in the Ghanaian Construction Industry

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Abstract
There exist several construction applications (Apps) used on mobile phones or tablets within the construction industry, yet there is a gap between technology design and technology use in the Ghanaian construction industry. The aim of this study is to find out the use of construction apps in the Ghanaian construction industry. The objectives were to find out the awareness of the use of construction apps and to evaluate the construction apps used in the Ghanaian construction industry. An extensive literature review was conducted to identify the construction applications available in the construction industry and were group under 5 main headings; namely, estimation, calculators, CAD, construction site and project management Apps. Field survey of Sixty-Two registered building and civil contractors in Ashanti Region was conducted. Questionnaires were distributed to top management team of the firms with a response rate of 89%. Data obtained were analysed with descriptive statistics techniques. The results show that majority were not aware of the use of construction apps by 58% of the respondents yet most use android phones or tablets that support Apps. However, the topmost applications normally used were site photos, microsoft, spirit level, material estimator calculator, AutoCAD WS, Construction Master Pro, Universal Estimator, AndCAD, Carpenter's Calculator, and painting estimator. It is however important that tertiary educational institutions pursuing construction related programmes should from time to time educate the young construction engineers about the modern and importance of the usage of these construction apps to enhance efficiency in their operations.
Keywords: construction Apps, contractors, construction industry, mobile phones, Ghana.

1.0 Introduction
Productivity improvement is one of the main goals of the construction industry (Abdel-Wahab and Vogl, 2011; Azhar and Cox, 2015). The industry is constantly looking for means and methods to improve the efficiency and productivity at the jobsites (Chen and Kamara, 2011). The integration of smart or android mobile tools and technologies such as the use of phones, tablets among others into construction operations management can help enhance the jobsite efficiency, quality, and productivity (Azhar and Cox, 2015). It is usually acknowledged that a gap exists between technology design and technology use, with the result that users generally need to adapt technology once it has been acquired and in practice of which the Ghanaian construction industry is of no exception (Heeks, 2002, Sey, 2011).

Improving technologies of smart devices and mobile computing provide unprecedented opportunities to innovate the existing management processes. After invading the consumer market, nowadays smartphones and tablets are quickly becoming common and natural extensions of industrial networks too. Several attempts have been made in utilization of various mobile computing devices also on construction project management; rugged construction tablets have been around for a decade or more (Kim et al., 2011; De Dominicis, 2013). That said, smart devices such as tablet and smart phones have some winning features that allow them to impose on other types of mobile hardware: they are light, compact, relatively cheap, high performing and very user friendly. In particular, user friendliness and pervasiveness grant that management applications are usable not only by the experts but rather by the people on the field who need to safely and successfully operate the system (De Dominicis, 2013). Mobile technologies are expected to initiate the next wave of technological development, which will transform the construction industry to the next level of technological advancement (Anumba and Wang, 2012a&b; Wang and Dunston, 2012; Wang et al., 2013). In the United States and other developed or developing countries, the adoption of this technological change is driven by companies who look to their younger, newer employees to drive the adoption of technological change such as this because they are assumed to be familiar with the latest technological innovations available in the construction industry (Davids, 2015).
The objectives of this study were to find out the awareness level of the use of construction Apps and to evaluate the construction applications used in the Ghanaian construction industry.

2.0 Literature review
2.1 Construction Apps
Since the introduction of Apple's Apps store and Google's Android Market (now Google Play) around the late 2008, there has been a number of application which downloads exceed 102 billion of which the construction industry is of no exception. Sources (Subramanya, 2014; Nourbakhsh et al., 2012; Singleton, 2011; Azhar & Cox,

2015, Google Play store) gave the examples of Apps used in the construction industry among others:

Table 1: Apps examples and uses

S/No	APPs	Uses	Source
1	CAD, Design and Drawing		
	AutoCAD WS AndCAD Rilievo DAKO PRO Civil Engineering	Access and edit all of CAD files. It supports all AutoCAD files and has features It handles architectural surveys and was built to eliminate the need for paper surveys. This app, by DakoSoftware, is built specifically to help meet the design needs of civil engineers.	Singleton, 2011
2	Calculators		
	Concrete Design Carpenter's Calculator Construction Master Pro Roofing Calculator Concrete calculator	Calculate the amount of concrete and reinforcement needed for a work. The app has features that check the compression zone and cracking. This app covers the basic needs of carpenters on the job site. It also used for calculations for roofing and pitch. It helps to compute standard construction calculations and trigonometric functions. That means contractors and construction workers can tally estimates for everything from stairs to concrete. Calculate material costs Calculation materials of concrete	Singleton, 2011 Azhar & Cox, 2015 Google Play store
3	Estimating		
	Universal Estimator A Estimate All Pro Painting estimator Material estimator calculator	Universal Estimator handles multiple types of projects, including painting, flooring, framing, and roofing, right from a single app. Handle all types of estimating – from concrete, painting and remodeling to other construction estimating jobs Accurately estimate paint projects. Estimate paint cost, material cost and profit and overheads. Estimate materials and cost of concrete, fences, decks, bricks, tiles, flooring, gravel, painting, drywell and paneling	Singleton, 2011 Google Play store

Table 1: Apps examples and uses continued

S/No	APPs	Uses	Source
4	Construction site		
	Spirit level	Checking levels at construction site	
	Site Boss	Checking Site Diary, Request for Information, Purchase Order, Change Orders/Variations, Backcharge Notice, Site Instructions, Meeting Minutes, Tender Request, and Extension of Time Picture taking	www.contractors apps./our-apps/ site-boss, Azhar & Cox, 2015 Google Play store
	Site photos	Site records, weather and site conditions	
	Daily construction records		
5	Project Management		
	iConfirm	Keep all of your site documents in order with the iConfirm app, which can manage job site verification forms, change orders and photo documentation. Documentation can be signed directly on your phone, and all documents are legally binding.	Singleton, 2011 Google Play store
	Tradies App	The suite features a site diary, change orders, invoicing, quoting, requests for information, purchase orders and bid requests.	
	Construction manager	Use to track of projects and tasks. Get feedback from subcontractor and customer	
	Architecture of the Construction Mobile Application	Inspection Report, QA/QC report, Design Intent and Clarification, and site instruction are the data generated by the consultant. Schedule Update, Accident Report, Violation Report, Productivity Information, Progress Photo, Daily Report, and Delay Recording are data produced by the contractor. The data flow between contactor and consultant	Nourbakhsh et al., 2012
	Microsoft Office	Checking word doc, spreadsheet, pdf and power point files other Microsoft files	

3.0 Research methods

In achieving the research objectives by finding out the awareness level of the use of construction Apps and to evaluate the construction applications used in the Ghanaian construction industry, and to gather the necessary data while overcoming data collection challenges such as time and cost, this study used the quantitative research approach.

Questionnaire was used as the survey method which was highly closed-ended questions. It was structured in three main areas. Thus respondent's background, to find out the awareness of the construction Apps and to evaluate the construction applications used in the Ghanaian construction industry. Respondents responded to the construction Apps that related to the various disciplines.

The population for this study comprised registered members of the Ashanti Region branch of Association of Building and Civil Engineering Contractors of Ghana. There are sixty-two (62) members of contractors in good standing who have also registered with the Ministry of Water Resources, Works and Housing. Building and civil contractors' in-house top management team who were; project managers, quantity surveyors, architects, and general foreman were used for the study. The top management of these firms was selected because that most had the widest exposure to a construction projects, and are also involved in various project phases including planning, design, and construction. Purposive sampling technique was adopted for selecting project managers, quantity surveyors, architects, and general foreman. Thus those who had knowledge on the study understudy. The sample size used for this study was all members with a response rate of 88.7%.

Respondents were asked to evaluate the frequency of usage of construction Apps using Likert scale from always to never. The 5 scale used was 5 – always, 4- very often, 3 – sometimes, 2 – rarely, 1 – never. The data obtained were analysed using the descriptive statistics.

4.0 Results and discussion

4.1 Respondents' professional category

Out the 55 construction firms surveyed, all the top management of the building contactors responded representing 100%. The representatives were project managers, quantity surveyors, architects, and general foremen.

All the respondents had working experiences. 11-15 years working experience was the highest with 32%. This shows that respondents had more experience in the field of study. It is followed with 0-5 years, 6-10 years representing 29%, 25% and respectively. The least had 16 years and above with 14% of the respondents.

4.2 Educational background

Table 2: Educational background of respondents

S/No	PERSONNEL	EDUCATIONAL BACKGROUND						Total
		MSc	BSc	HND	Technician	SHS	Not been to school	
1	Project Manager	12	37	6	0	0	0	55
2	Architect	1	53	1	0	0	0	55
3	Quantity surveyors	5	16	29	5	0	0	55
4	General foremen	0	0	24	28	3	0	55
	Total	**18**	**106**	**60**	**33**	**3**	**0**	**220**
	Percentage	8.18%	48.18%	27.27%	15.00%	1.36%	0%	100

All the respondents have had education. This is important to determine the awareness and use of the construction Apps in the construction industry. Majority were BSc holders with 48%. It followed with 27% that had Higher National Diploma (HND) and Msc holders with 8%. These respondents have had tertiary level of education. The least of 1% of respondents had Senior High School education.
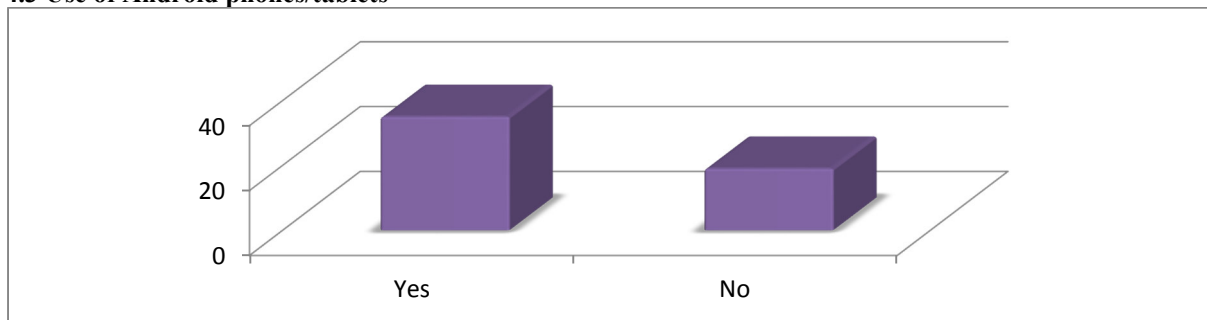
4.3 Use of Android phones/tablets

Figure 1 Use of Android phones or tablets

Majority of the respondents had android phones or tablets for their operation by 65% of the responses. These respondents had phones or tablets that support construction Apps. Only 35% of the respondents do not use android phones or tablets.

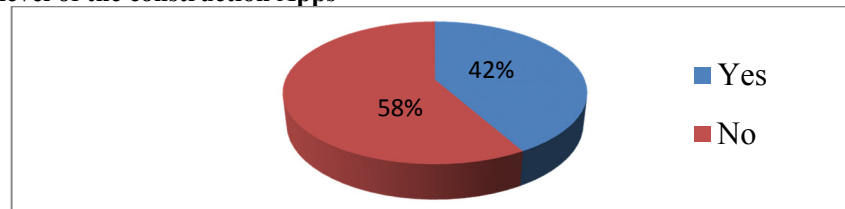### 4.4 Awareness level of the construction Apps

Figure 2 Awareness of construction Apps

It is surprising to state that majority of the respondents had android phone or tablets yet majority of members were not aware and have not use of construction applications by 58%. 42% of the respondents were aware and have used construction Apps in their operations.

4.5 Construction Apps Usage

Table 3: Construction Apps Usage

CONSTRUCTION APPs	MEAN	SD	RANK
CAD, Design and Drawing			
AutoCAD WS	1.80	5.13	5
AndCAD	1.65	5.23	7
Rilievo	1.44	5.17	15
DAKO PRO Civil Engineering	1.49	5.12	12
Calculators			
Concrete Design	1.45	5.05	13
Carpenter's Calculator	1.64	4.46	8
Construction Master Pro	1.78	4.21	6
Roofing Calculator	1.56	4.63	10
Concrete calculator	1.56	4.59	10
Estimating			
Universal Estimator	1.65	4.39	7
A Estimate All Pro	1.45	5.05	14
Painting estimator	1.62	4.60	9
Material estimator calculator	1.85	4.20	4
Construction site			
Spirit level	2.04	3.70	3
Site Boss	1.55	5.03	11
Site photos	3.02	3.99	1
Daily construction records	1.56	4.92	10
Project Management			
iConfirm	1.45	4.95	13
Tradies App	1.36	5.24	16
Construction manager	1.45	4.98	13
Architecture of the Construction Mobile Application	1.36	5.24	16
Microsoft Office	2.18	4.83	2

Out of the 22 construction Apps identified. Respondents were asked to evaluate the Apps usage in relation to their various prospective disciplines. The topmost ten (10) Apps used by the top management team of the building contractors were site photos, microsoft, spirit level, material estimator calculator, AutoCAD WS, Construction Master Pro, Universal Estimator, AndCAD, Carpenter's Calculator and painting estimator. This indicates that construction site apps were needed by respondents to do most photo taking for record and reporting progress at construction site. This followed with Microsoft apps for reading minutes of site meetings, and other project documentation both at site and office practice (Subramanya, 2014; Nourbakhsh et al., 2012; Singleton, 2011; Azhar & Cox, 2015, Google Play store). Five categories of Apps identified. In terms of CAD Design and Drawings, AutoCAD WS was the highest Apps used by professionals for drawings. Construction Master Pro was the most often use calculators for checking materials used in buildings. Material estimator calculator was the highest among the estimators Apps. Spirit level and site phones were both highest among the construction Apps used. Microsoft Apps was the highest Apps used by project managers for their operations.

5.0 Conclusions and recommendations

A lot of construction applications are available for use in the Ghanaian construction industry. From the study, construction Apps have still not been fully utilised in our construction industry. Majority of the respondents had android phones and tablets that support construction Apps yet it is the minority of the respondents that was aware and has used construction Apps in their operations by 48% of the responses.

The topmost ten (10) Apps used by the top management team of the building contractors were site photos, microsoft, spirit level, material estimator calculator, AutoCAD WS, Construction Master Pro, Universal Estimator, AndCAD, Carpenter's Calculator, and painting estimator. However, these Apps were grouped into five as identified namely; estimation, calculators, CAD designs, construction site and project management Apps.

It is however important that tertiary educational institutions pursuing construction and engineering related programmes should from time to time educate the young construction engineers about the modern and importance of the usage of these construction applications to enhance efficiency in their operations.

Building and civil contractors should try and set some budgetary allocation for the purchase of current android phones or tablets with construction apps to be used at both office and construction sites.

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