Developing Core Android Software to Operate and Manage the Data of Ongoing Live Projects for Civil Engineers

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***Abstract*—This paper aimed to develop a mobile app that recommends the digitization of entire physical documents required for civil engineering projects, thereby automating business processes through mobile technology, which enables the significance of document digitization, the evolution of paper-based documents to electronic documents, hard copy to soft copy delivery, and mail to electronic document transfer and management capabilities that allow construction companies to build deeper and more profitable electronic relationships with all users. The supporting tools are available as a plug-in to various software development environments such as Eclipse, Android Studio, etc. The Java language used for programming the application is a modified version, as Android does not support all the credentials of standard Java. Android does not support some Java libraries, such as the user interface libraries; for this, it has its own customized libraries.**

I. INTRODUCTION

The construction industry still relies heavily on paper-based documentation such as drawings, contracts, invoices, reports, schedules, and approvals. Managing these physical documents is time-consuming, costly, and prone to loss or damage. The thesis proposes an Android-based mobile application called Civil Docs to digitize and manage project documents for civil engineering projects.

Depending on the context, this knowledge may be used in a variety of ways, e.g., to inform a design decision, to aid in education of key concepts, or to identify the level of risk for a given scenario. Due, in part, to both improved understanding and perpetually increasing computational power, we have become accustomed to a regular increase in the accuracy of these simulations. Modeling and simulation are an integral part of modern engineering as they allow the user to improve their understanding of physical scenarios and complex systems. 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, a 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 the 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

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. Software plays a central role in almost all aspects of modern-day life. It can be defined as the instructions that cause the hardware (machine) to do work. Software is a computer program along with its documentation. It can be developed for a customer or may be for a general market. (Sommerville, 2007). Along with this, Pressman (2005) defined software as the combination of instructions (computer programs) that, when executed, provides desired features, functions, and performance. The number, size, and application domains of computer programs have grown dramatically. As a result, billions of dollars are being spent on software development, and the livelihood and lives of most people depend on the effectiveness of this development. (Asmaa and Heba, 2014).

The two primary software categories are system software (Operating System, OS), which controls the workings of the machine (computer, mobile device, etc.), and application software, which addresses the multitude of tasks for which people use the machine or device. System software, therefore, handles such essentials but is often invisible or underground, doing chores such as maintaining disk files and managing the screen, while application software performs word processing, database management, and so forth. Two additional categories, although they contain elements of both, are network software, which enables groups of computers to communicate, and language software, which provides programmers with the tools they need to write programs. In this project work, the software category developed is application software as stated in the project title. We are developing mobile Android software to operate and manage data of construction projects. The maintaining and retaining of project documents and data is very critical. The importance of maintaining and retaining project documents and data should not be overstated.

In order to have an effective and manageable document management system, it is important to anticipate what parties and documents will be involved. Parties may include owners/developers, architects, engineers, general contractors, subcontractors, suppliers, inspectors, lenders, and others. Relevant documents may include

contracts/agreements, plans and specifications, drawings, schedules, insurance policies/programs, notices, progress/inspection reports, draw requests and pay applications, change orders, permitting, code compliance and occupancy documentation, as well as communications. Today, mobile devices, or smartphones, are everywhere. They are more prevalent than personal computers. They have replaced our watches, calculators, cameras, and MP3 players and have often become our means of internet access. They also provide capabilities such as GPS navigation, motion and gesture interfaces, social networking, and numerous arrays of applications that mix and match many features. With all of this, it is also handy, which makes it easier to see why mobile devices are popular. (Steele, 2011). Smartphones are acting like a computer, Smartphone's may be thought of as handheld computers, it also provides facility to store data such as information, documents etc. This data can be shared with anyone and anywhere through the internet and application software like Bluetooth, ShareApp, etc. These smartphones are very helpful and useful for doing business smartly. Today any person can use a smartphone because they are available at low cost in the market. Smartphones are flexible in compatibility, and they provide multiple features that attract people. There are more than fifty million applications available for download from app stores.

YEAR	2011	2012	2013	2014	2015	2016
FREE DOWNLOADS, (Billion)	22.1	40.6	73.3	119.9	189.0	287.9
PAID FOR DOWNLOADS, (Billion)	2.9	5.0	8.1	11.9	16.4	21.7
TOTAL DOWNLOADS, (Billion)	25	45.6	81.4	131.8	205.4	309.6
PERCENTAGE FREE DOWNLOADS,	88.4	89	90.1	91	92.2	93

II. SUMMARY

This thesis focuses on developing an Android application called Civil Docs for civil engineering projects. The app helps engineers digitize, store, manage, and retrieve project documents such as drawings, contracts, reports, and approvals. The main objective is to replace traditional paper-based document management with a secure digital system. The application was developed using Android Studio, Java, and XML. Key features include document scanning, PDF generation, project management, secure storage, search functionality, and document sharing. The system improves efficiency, reduces paperwork, saves storage space and costs, and enables access to project data anytime and anywhere. Overall, the project supports digital transformation and smart document management in the construction industry.

III. USE OF ANDROID DEVICES FOR ENGINEERING SIMULATION

A survey of device ownership in the US in 2015 [2] revealed that 68% of the US population owned a smartphone and 45% owned a tablet. Globally, smartphone ownership hit 1000 million in 2012 and is set to exceed 2500 million by 2020. Ownership is spread across all continents, with South Korea leading the way, where 88% of the population owns a smartphone. Ownership in so-called advanced economies, including the US and much of Europe, is approximately 68% on average [4]. Modern mobile devices are designed to include a multi-core CPU and a GPU, providing similar versatility to a desktop computer. The computational power of these chips has increased approximately tenfold since 2009 [5], and available RAM has also increased, with more than 3 GB typical of current high-end Samsung Android devices (Fig. 1). Current engineering workstations may have 16 cores and 64 GB RAM with which to perform a local simulation—a 4x increase in CPU cores and a 16x increase in memory. Furthermore, due to active cooling mechanisms on desktop computers, clock speeds are often much higher increasing computing power further. Halpern et al. [5] show that power consumption for mobile chips has increased, although further increases in power consumption are yielding less of a gain in performance, causing a power saturation at about 1.5 W. Instead, the most recent smartphone design has increased the number of cores rather than increasing the power per core. One may conclude that mobile hardware development is hence

limited by its power-conserving motivation. However, in defense of mobile devices, the widespread ownership of mobile devices, combined with the clear, albeit restricted, increases in power and capability, makes the platform a potential candidate for running smaller-scale engineering simulations on-site without reliance on external resources or connectivity. Although an individual device may not be able to offer the power of an HPC facility, simulations could be performed on a network of devices connected by a local network implemented via Bluetooth or Wi-Fi Direct. High-end HPC facilities, at present, typically offer O (105) cores and O (103) GB of RAM according to the TOP500 list. However, in practice, these resources are shared amongst many users with individual jobs using much smaller allocations. Access to such facilities is also generally restricted. Theoretically, if all 2 × 109 smartphones globally are assumed to be quad-core with 2GB RAM (c.2013), a global P2P smartphone computer could offer 8 × 109 cores with 4 × 109 GB of memory. This is purely hypothetical but illustrates the compute potential for even the mobile devices in a single office block or city. In light of hardware limitations for individual mobile devices, it is expected that in order to run a simulation locally, there will be a trade-off between the level of model complexity (and hence simulation accuracy) and the speed with which a result can be obtained. However, mobile platforms have the potential to provide sufficient computing power for rapid simulation to an acceptable and situation-appropriate degree of accuracy. This can only be realized with the development of a suitable framework for engineering simulation in this context. 2.1. Integration with existing infrastructure in our increasingly connected world, mobile devices also have the option to off-load tasks with a high resource demand to more suitable systems [6]. In the case of engineering simulation, mobile devices may provide input data such as local wind speed and direction, measured structural loads or geometry, and materials, all recorded locally on the device, to a remote HPC facility, which performs a potentially demanding calculation using these system data. A data-reduced result may then be returned for the user to inspect. It may also be possible to perform some part of the simulation locally as a coarse approximation to the problem physics while simultaneously performing a more detailed analysis remotely, which may be viewed or incorporated into the local platform at a later time (Fig. 2). However, presently HPC facilities are expensive to build and maintain, and access is typically restricted. Furthermore, network connectivity is not available in every location and may also suffer from reduced bandwidth or unreliability. A common interconnect between HPC facilities and external terminals is of the order of 1 Gb/s, which gives a maximum theoretical throughput of 125 MB/s. The fastest mobile data connections in the UK at present use the LTE-A (4G+) standard and will theoretically support such a transfer rate [7]. However, this service is, at present, only available in select areas and at a premium subscription cost to a user. Typically, connection speeds may be as low as 12 MB/s depending on the infrastructure available. A sensible alternative may therefore be to develop approaches to performing the calculation locally on one or more available devices [8].

IV. SCOPE AND LIMITATIONS

Useful for construction companies handling large volumes of documents.
Supports remote access to project records.
Facilitates organized document management and decision-making.

Limitations
Works only on Android devices.
Requires a smartphone.
No notification/alert system.
Mobile devices have limited battery and processing power.

V. CONCLUSION

The thesis concludes that digitization of construction documents through a mobile application can significantly improve document management in civil engineering projects. The Civil Docs Android application provides a practical solution for storing, organizing, scanning, and retrieving project documents securely. It promotes efficiency, reduces paperwork, saves time and cost, and supports the ongoing digital transformation of the construction industry.

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