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Challenges in Maintenance and Evolution of Mobile Applications

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Abstract

The advances in mobile technology have brought an excessive change in the daily lifestyle of each individual in recent years. Smartphones or mobile devices are used in all aspects of human life. This leads to extreme demand for developing software that runs on mobile devices. Currently, we can see there is rapid development and evolution of mobile technology, which involves mobile communication, mobile hardware, and mobile software. Features of mobile phones largely depend on the software installed. In the modern information and communication age, mobile applications are producing a huge amount of data so it is one of the most concerned and rapidly developing areas. At the same time, mobile app development is undergoing major changes with the introduction of new software, service platforms, and software development kits (SDKs). These changes lead to the appearance of many new service platforms such as Google with Android and Apple with iOS. Good software development and particularly maintenance practices form an important factor for success in the software business. If one wants to constantly produce new successful releases of mobile software and applications, a proper efficient software maintenance process is the primary key. In this paper, Literature is conducted to highlight the Maintenance and Evolution process for mobile applications. The goal of the present literature survey presents information and challenges in the evolution and maintenance of the mobile application and gives some statistical data on the past and present situations.

1. Introduction

A mobile application called a mobile app or just an app is an application software designed to run on mobile phones, tablet computers, and other mobile devices. If an app has an interactive engagement with users or provides an application that requires to work more relative to a computer program than a website then it makes the desire for users to have it. Mobile apps are available through distribution platforms on associated app stores. App stores are having are free as well as paid apps and a few apps that initially are available for free, but later a minimum fee is required for having premium benefits. The iPhone has its powerful software, revolutionary user interface, and powerful development platform that has driven an almost overnight explosion of apps. The most widely used smartphones for mobile apps are Android phones, iPhones, or Windows Phone.

At first, mobile apps were developed for informational and productivity purposes only that included the apps like email, calendar, contacts, calculator, and weather information. With the rapid expansion in the technology and users' expectation, the developer has expanded into other categories such as mobile games, online banking, ticket purchases, online purchasing, social media, video chats, automation, location-based services, fitness apps, messaging apps, and recently mobile medical apps.

Mobile applications have arisen due to the combination of media, information technology, the Internet, and advanced technologies. In addition, mobile telecommunications has been the subject of research by handset manufacturers, wireless service providers, application developers, and many researchers in the field of information technology (IT) and information systems (IS) for many years [1].

However, the most interesting and ongoing research area is mobile application evolution. Specifically, mobile computing allows users to utilize their mobile computing devices to perform context-aware computing and portable communications. Despite these benefits such as context-awareness and portability, mobile computing faces some challenges that include limited device resources (battery, memory, and processor) along with issues of data security and privacy [10].

To conduct our study, we focus on answering the following research question:

RQ1: What are the challenging factors for the evolution and Maintenance of Mobile Applications?

In section II we review related work. In Section III, we discuss the Background of the study. In section IV, we summarize the findings.

2. Related Work

Many previous studies have focused on the evolution of mobile apps. For example,

[3] Conducted the first comprehensive study of the long-term evolution of mobile app usage. Specifically, about 1,500 Android users with six-year app usage records from 2012 to 2017 were covered for the analysis. Overall, Research findings indicate that users' app usage indeed changes over time. However, the evolutionary processes in app-category usage and individual app usage are different in terms of popularity distribution, usage diversity, correlations, and cross-country differences. Also, they demonstrated that the differences in demographics will affect the evolutionary processes of app usage.

[4] The challenges of mobile application development (native, web, and hybrid) were identified by this research work. Two research approaches were adopted to identify these challenges through conducting a Systematic Literature Review (SLR) and interviews with practitioners. They concluded, identified challenges were characterized by some key development knowledge areas where real-world practitioners should concentrate their attention to have considerable control over these challenges or Problems for successful and efficient mobile application development. By adopting both research approaches, nine challenges (i.e., Fragmentation, Testing, User Experience, Reuse of Code, Compatibility, Lack of Expertise, Change Management, Security) crucial to the success of mobile application development and four additional challenges (i.e., lack of training, lack of teams, lack of knowledge management and lack of communication) from interviews not found in the literature were identified. This allowed them to produce guidelines for identifying good practices in the development of apps as a way of expanding visitors' experience in these institutions through these devices.

[10] AN empirical software package engineering approach has been adopted to analyze existing solutions (30 revealed studies from 1996 to 2019) and by trial and error derive a method model that supports software evolution for mobile computing. A case study-based approach is adopted to demonstrate the process- centric evolution of existing software as a mobile-enabled application. Case study-based demonstration highlights that the projected method (i) supports a progressive evolution and permits user-decision support to guide the evolution process. Analysis results highlight computation and energy potency at the side of increased usability of a mobile application once dead on resource- constrained mobile devices.

[12] Work studied data from mobile application maintenance to understand and conceptualize how mobile application maintenance takes place. Based on the data on release history, different mobile application maintenance models (Emergency- oriented Maintenance, Feature-oriented Maintenance, and Constant Maintenance) were deduced from the perspectives of maintenance scheduling and maintenance requirements. They concluded that the three proposed models provide promising ways to organize better maintenance schedules and maintenance requirements.

[14] This paper was focused on how science centers and museums around the world have used mobile apps with museum guide characteristics and try to identify the best interface design principles to improve their use as a tool for interaction with the public. For this purpose, mobile apps were mapped from science centers and museums and applied an evaluation tool for each one to identify good practices.

3. Background
3.1 Generations of Mobile Applications
Phone makers designed and developed first-generation cell phones. The competition was fierce and trade secrets were guarded. They didn't need to reveal the secrets of their phones, in order that they developed the phone's software system in-house. Throughout this time, the primary "time-waster" games began to appear.

Nokia was famous for putting the Snake video game on some of its early phones (the 1970s). Because of these things, people started changing their attitudes towards communication. As cell phone prices fell and batteries improved, more and more people started carrying handy devices.

Currently, virtually 80% of individuals are online through mobile devices. Most of those people like mobile applications because they are simple to use and perform tasks instantly. Users become additionally dependable on the mobile application once they determine easy tasks like booking picture tickets, checking sport's scores, shopping for and selling, or several alternative similar routine activities. These tasks are resolved with one click. A mobile app accessible on an apps store has more probability to convert visits into business. That assists to extend the rate of sales.

3.2 The challenges of Mobile Applications
The main and biggest challenge of mobile application development is to make the developed app visible to people then only people will find it and download it. If an app is not among the top 50-100 across a category in an app store, people will hardly ever download it. One of the challenges of mobile applications is their limitation and the capability of the platform. In addition to the interesting usability of mobile applications, they have some problems connected with the platform and limitations.

Some of the main problems are listed below:
- Screen size-Mobile screen size is small. So, on a mobile platform, it is harder and impossible to view text and graphics like on a desktop computer screen.
- Lack of windows-We can see many windows at a time on a desktop. We can handle many tabs on a mobile screen. However, it can hardly be realized on a mobile platform.
- Navigation - Most mobile devices do not have a mouse-like pointer, so it has limited flexibility in navigation.
- Types of pages accessible - As a rule, mobile platforms do not support all types of file formats.
- Speed- The speed of processing and speed of connectivity of mobile platforms is slow.
- Size of messages or email- Many devices support a limited number of characters in messages or email.
- Cost- The cost for cell phones, mobile applications, and

Internet connection is high.

3.3 A Complete Evolution of Mobile and Mobile Apps

Mobile applications have become an integral part of our lives, offering us an application for all our needs, from the most mundane to the most important; from booking a taxi, ordering food, playing games, shopping online to staying with our loved ones on the other side of the world. So much so that more than 80% of our time is spent on our mobile apps. But how did everything start and evolve to such advanced and accessible technology?

It all started with the first smartphone that IBM released for general use in 1993. The first smartphone came with features like a calculator, world clock, calendar, and address book, all coded in Java.

The next big thing in mobile app development can be associated with Blackberry – it took mobile apps to the next level. Blackberry came with built-in email, arcade games, ringtone editors, a to-do list, and more. These apps are the ancestors of the mobile apps we love and use today.

The next big milestone in terms of apps can be marked with the release of the first iPhone in 2007. This was a big deal for most of us. The iPhone has drastically changed the history of mobile and mobile applications. That was the time when most people decided to ditch physical keyboards and embrace the new multi-touch screen technology.

Before the iPhone came out, smartphones were big, clunky devices, half a keyboard, and half a screen. Whole websites didn't run on mobile devices, forcing companies to create weak mobile versions of their websites. Apple changed all that, but at what cost? In fact, it took Apple $150 million and two and a half years to create the first iPhone.

Although by today's standards, the primary iPhone seems like a primitive brick, it stands as a reminder of the long way generation and mobile application improvement has come.

Over the years, simple Applications have had the possibility to make and design a large kind of app, some we have a tendency to make to save lots of lives, others to keep users entertained. We've designed apps to assist business owners to manage their inventory a lot smoother, we've built apps for hospitals and even for companies. There is the magic behind transferring ideas to life, and though we don't know wherever mobile applications can take us next, we are up for any challenges.

3.4 Mobile Application Maintenance

Under the background of the present competitive Intensive mobile application market, the daily increasing rate of recent applications is enormously high whereas numbers of applications aim for a similar user cluster and share the same functionalities. Therefore, the merchandise that perpetually offers continuous prime quality and exciting new options from time to time can take the leading position and be recognized by additional potential users. Regarding the development of code quality, methodologies are alleged to contribute to either the product itself or the method.

Maintenance for mobile applications is aiming to maintain high quality and stable performance. The improvement of the mobile maintenance process is therefore of great importance accordingly. To better organize the process of mobile application maintenance coping with the competition and unpredictability of the market, a maintenance schedule, which is defined as the continuous planning timetable for the mobile application maintenance process, should be used

as one of the tools.

Besides coping with the maintenance requirements of previously mentioned types, occasionally adding new features to existing software is of great importance to mobile applications. We outline a brand-new feature as a new sort of service or new expertise provided by the application, reminiscent of avatars, game themes, rewards, tasks, and so on. Despite the fact that adding new features is somehow considered as part of perfective maintenance, we emphasize the importance of adding new features in the Mobile application maintenance phase and consider it a unique maintenance type besides the existing four.

The importance of adding new features in the mobile application maintenance phase is indisputable, and the maintenance process lasts till the software closes down. Resulting from the variety of user feedback and unpredictability of market trends, the maintenance should be organized iteratively. Therefore, a well-organized maintenance schedule including a reasonable new feature updating frequency is important, and that schedule should be well planned for mobile application maintenance.

Considering the maintenance process in general as one stage, that stage shall contain components or properties including objectives, inputs, outputs, and methods. Before the actual maintenance process starts, certain input conditions must be clarified, taking into account possible influencing factors. For example, mobile application business models, objectives, and market trends influence the choice of maintenance requirements. The situation of the maintenance team and customers, on the other hand, affects the organization of the maintenance schedule. Feedback from end-users simultaneously provides maintenance requirements and schedule management guidelines.

Taking all input information into account, the maintenance process is an iterative process of working on a certain amount of maintenance requirements, according to the maintenance schedule with a certain maintenance method (the method of managing maintenance requirements and Schedules). Apparently, the outcome of maintenance work comprises application releases with updated content, recorded in update history. The recorded release dates suggest a maintenance schedule while updated content shows which maintenance requirements are fulfilled. Thus, we are investigating the possibilities to deduce possible maintenance models based on the update history.

3.4.1 Why Mobile Application Maintenance is Important

- **Getting the most recent Versions of the Operating Systems:** If you would like to rule the app world android and Apple, each continues updating their operating systems on a regular basis. They're in competition whenever there's an advancement within the technology. Therefore, you want to bear in mind the facts; whether or not there are a variety of apps that might stop operating on new versions that don't support them.

  For example, Apple recently launched the iOS 11 version and they concentrate on working with the iOS 10 version several apps to be supported and that they didn't operate within the below version. Whereas examination to android they conjointly have launched the android 8. Once in an exceedingly year, the operating systems get updated to try to give the proactive audit to the users once the beta version is

created and accessible in-app store. The development team can have a discussion and they recognize what changes are to be made in the app. And it is a good call to take care of the app maintenance higher while not this one they will lose the users, who get irritated when the app doesn't support.

▪ **The advance in computer code Libraries:** Well, if you're in the mobile app business, you need to realize the importance of software libraries in app creation. For software, the library will be finished with prewritten codes, configurations, associate degreed routines, and also the developers update or improve it. Whereas compared to all or any apps a number of them haven't software libraries and the ones that have must be fully up to date.

▪ **Offers an Updated user interface (Ul)** within the mobile app the user interface continuously be updated and advanced. This means that the users would like to stay engaged and it has to be ensured that they don't uninstall the app because of technical issues or other issues. Whereas seeing a mobile app marketing ought to have a lot of refined looks. Currently, you'll know of these execs if you're maintaining your app correctly.

▪ **Obtaining Improved User Expertise (UX):** a modern study describes by informing that app maintenance has played an important role in generating more traffic and better ratings from the users. This statement shows the importance of app maintenance and also the success of your mobile application. If the app is launched within the store, you have to monitor it often for any issues, add new features, fix the bugs, and update it to retain users. So, if you would like to induce a lot of audiences, then the user experience should be totally happy by providing an updated and latest version of the app must always be your priority and necessary one also. It's the main issue that informs whether people can download your app or not.

▪ **Incorporating Technical Enhancements:** these days the mobile primarily based technology keeps on ever-changing by giving updates and each month or two we have a tendency to understand a replacement set of the technical setting for the mobile apps. What is going to the updates could embody just like the programming languages, new platforms, technology, and far more. If you're entering into the mobile application maintenance service, they need also make the changes with competence as per the demand then you may not notice any problems by giving the most recent version. Once you are maintaining the app as the primary factor as a secure platform, you're providing it. These days app security is changing into an important aspect, all the apps are currently providing encryption services and keeping visible the robot and loss mobile app developers decreasing the number of cyber threats. From the technical point of view, it'll stay error-free.

3.4.2 Types of Mobile App Maintenance
▪ **Emergency Maintenance:** If any hassle happens the hassle needs to be solved with some more hours if it arises constantly in the mobile app which we want to be addressed immediately.

▪ **Perfective Maintenance:** For making modifications in the source code to provide new features and functionalities to deal with user necessities this sort of

maintenance is used.

▪ **Adaptive Maintenance:** In adaptive maintenance, few modifications are made in the software to maintain the device up to date with the adjustment in a running environment like operating system or hardware.

▪ **Preventive Maintenance:** It is supposed to prevent the prevalence of mistakes. It consists of code optimization, code restructuring, code restructuring, and documentation updating.

▪ **Corrective Maintenance:** Corrective maintenance is used to discover any defects that take place in regular software functions, which includes mistakes associated with design, coding, and application logic and repairs the faults.

4. Conclusion
In recent years, mobile application development for smartphones has evolved staggeringly thanks to ubiquitousness and recognition among end-users. This fast interest has drawn mobile application developers' attention over the previous couple of years. Because the business of mobile application development is evolving rapidly, we have a tendency to be motivated to spot challenges in mobile application Maintenance and Evolution.

Our study aims to supply mobile application developers with a comprehensive set of challenges that will assist them within the development of mobile applications. Characteristics of these challenges will facilitate industries to be prepared for economical mobile application development and facilitate them within the productive completion of mobile application development projects.

5. Acknowledgments

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