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Quality Attributes Demanded By Mobile App Stores On Mobile Apps Hosted On Their Platforms.

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Abstract.

Mobile applications are designed and developed to run on a mobile device. The overwhelming adoption of mobile device technology, the rapid advancement of mobile devices and the significance of the Internet in today's society have shifted how businesses and consumers interact. The shift has subsequently upset mobile software programming enormously. The education sector has not been left behind on the adoption of mobile devices. For a mobile app to publication in an app store, the developers must meet the quality requirements of the store. To obtain the requirements, we surveyed four major app stores by leveraging the ISO/IEC 25010 quality standard to ensure the fulfillment of the quality requirements from the mobile app stores. We used the cross-sectional methodology strategy thus conducted the study within a limited time frame. Once an app is published in an app store, it becomes accessible to the entire universe of users. Mobile app developers should be familiar with the quality control requirements to develop acceptable apps. The purpose of this paper was to survey and identify the most relevant quality requirements set up by

mobile applications The study found, Usability, Performance, Maintainability and Support categories were the most important

Keywords: app store, quality attribute, quality standard.

1.0 Introduction

The overwhelming adoption of mobile device technology, the rapid advancement of mobile devices and the significance of the Internet in today's society have shifted how businesses and consumers interact. This change has subsequently upset mobile software programming enormously. The education sector has not been left behind on the adoption of mobile devices. Today, almost every transaction has moved to the mobile device, including m-banking, m-commerce, e-citizen, e-learning, among many others. This move has caused a proliferation of mobile apps (apps) targeting various market segments; hence, the domain has become very competitive. According to Statistica.com, Google Playstore had 3.48 million apps, followed by Apple Store with 2.22 million in 2021. Three things can be considered to be the cause of this proliferation of millions of app: the availability of smart mobile devices, mobile app developers and demand for the apps.

The proliferation of mobile apps has heralded a new business model where mobile the development and distribution of mobile software is centralized (Bergvall-Kareborn and Howcroft, 2013). App stores have set up policies and publishing guidelines to be followed by developers (Ricardo, 2014). In such a case, the quality of mobile apps becomes of paramount importance.

2.0 LITERATURE REVIEW

2.1 Mobile App Quality

Users' satisfaction with an app is vital in determining the quality factors of mobile apps. Ricardo (2014) proposes three dimensions to view the quality of mobile software conformance to specification and ability to meet the user needs. The dimensions are the end-user of the mobile app, the mobile environment where the app executes and the regulations of the mobile app markets.

The mobile app development environment is significantly different from the conventional software environment. For example, mobile devices have smaller screens, tiny keyboards, and limited power, among other issues. Likewise, network technology such as signal power and interoperability of different technologies affect mobile apps. Hence, the ability of a mobile app to adapt to these constraints influences its quality.

Mobile app quality is how the user performs and experiences the app under the constraints of the mobile application environment.



The success of a mobile app means that user needs are met.

However, it is difficult to have an app that satisfies users sufficiently because usability issues are hinged on small screen displays, the context of use (geographical and weather conditions influence mobile users whose mobile app usage), limited data input methods, and connectivity influenced by location. Battery and memory are still constraints as they are limited in mobile applications than in conventional software (Pavaloaia, 2013).

The processing power of a mobile app is limited, yet such apps need to be transferred to various platforms to serve different users with similar needs effectively.

This paper reviews quality requirements by major app stores concerning the ISO/IEC 25000 family, also known as SQuaRE. It contains a set of standards relative to software quality. These standards define management guidelines, quality models, measures, requirements, and software evaluation processes.

The proliferation of mobile apps has necessitated new studies concerning the standardization of mobile app development.

In this study, we identified the most relevant quality requirements formulated by different app stores to be met by mobile apps by surveying the publishing guidelines of four major app stores.

App stores allow users to find, install, update, and uninstall mobile apps from their devices.

The quality control mechanism helps provide a trustworthy guide for potential users of the published mobile apps.

The main purpose of mobile application stores is to provide mobile app users with various choices and application interfaces. Hence, mobile application stores need to perfect their service quality, particularly considering the competitive customer service market.

According to Corral et al. (2014), several studies propose sets of quality characteristics for apps, and there are various app store guidelines used to obtain a list of quality characteristics.

According to Ickin et al. (2012), the user acceptance of a mobile app depends on the user's needs and context and the perceived experience (Quality of experience) from using the app. Experience quality factors include application performance, mobile phone features, interface design, battery efficiency, application cost, user routine, connectivity, and user lifestyle.

Relevant user experience means that an app is enjoyable, satisfying, interactive and helpful (Francese et al., 2017).

2.2 Mobile App Store Business Model

2.2.1 Google play Store

Google play developer website has well organized and elaborated quality guidelines published in January 2018. Google identifies the following quality issues in its guidelines, *Visual Design and interaction, functionality, compatibility, performance, stability, responsiveness, security and testing*. These are explained herein.

The mobile application is consistent and intuitive in visual design. Developers to use a standard design, navigation and notifications.

The mobile app should function as expected and give the appropriate permissions level and installation requirements. The app's location, audio, user interface and graphics, and user app status should be included.

Compatibility, performance, stability and responsiveness, are qualities expected in the app. It should load quickly, not crash, use the latest SDK, support power management features, media and visual quality.

Security issues identified are user data policies and laws when handling user data and personal information—security on the data, app components, network security, libraries execution, and cryptography.

Google expects to test for all the quality requirements.

2.2.2 Apple App Store

The Apple store has the second largest collection of mobile applications globally; there are quality guidelines in human interface, system capabilities, visual design, safety, performance, design, legality, and *privacy*. These are explained briefly herein.

Human interface essentials: These are navigation, views, controls, data entry, feedback gestures, undo and redo buttons. System capabilities should have the ability to multitask, give timely notifications and printing services to the application. Visual design guidelines are on the screen sizes and orientation, icons and images, bars and extensions.

Safety in content and protection from physical harm: The content should not be obscene, and people should not come to any physical harm while using the application. Design is original and or provide a minimal function or spam. Performance in-app should include compatibility, beta testing, accurate time, hardware compatibility and software requirements.

Privacy of users: Data collection protection, data use and sharing, location services, and intellectual property must be safeguarded.

2.2.3 Microsoft Stores

Microsoft stores, the quality requirement of the app are provided in the app quality segment, while others are in the company's policies. The quality issues identified by Microsoft are *functionality, security, testability, usability, privacy, localization, notifications, content, battery efficiency* and response to *customer feedback*.

Functionality is where the user has a quality experience with the app.

Security here refers to user security, security in the functioning of the mobile application and security of the rest of the device systems. *Testability* of all aspects of the app must be testable from the mobile application side. *Usability* includes software, hardware; screen resolutions specified by the app should be easy to use. The app must be responsive to user input.

Privacy of all personal information must be secured, not shared with other applications. Users must know which information is collected and how it is used. Capabilities stated for the application must all function. The store does not accept partially working applications. *Localization*, for example, is the use of appropriate language and the appropriate time for the country or region. *Notifications* should work appropriately and must not be a nuisance to users. *Content* should not harm the user in any way. It should not be obscene, insulting or demeaning in any way.

In-app quality features, Microsoft store, advises developers on building an app with multiple features and lasting value. The icons, title, description, screenshots and trailers must be done in marketable way for the app to appeal to potential customers/users. Metadata sells the app.

Battery efficiency: An app should efficiently use the battery to ensure the user gets value. It enhances the user experience. Easy to use and appealing: Most mobile application users are not willing to read long instructions or manuals and do not wish to contact the vendor for instructions on use, hence, an app should inherently be easy to use and appealing.

Further, mobile app developers should provide value and be generous to the user. Generosity could be a free app or very low cost or limited free use time. Developers should also engage their customers and respond to their feedback as fast as possible.

This means that mobile app developers should strive to address customer issues on a 24/7 basis (at all times)



2.2.4 Amazon Store

The amazon store operates on Android and Fire Operating systems. The developer guidelines on quality are similar to the other app stores. These are *functionality* and *reliability*, *usability*, *performance*, *connectivity*, *security* and *testing* as explained below:

The functionality and reliability of an app imply that the app should have core features by planning and should always find the most effective way of solving the problem. For example, an app should have consistent platform functionality and easy transition to another device. Feature addition that is different from the competitors is considered a key selling point. Developers are encouraged to look at other similar apps and see what extra features are added. *User experience*: An app should be user friendly and intuitive. *Usability* will lead to acceptance and adoption. *Performance* is important but should not interfere with core features. Performance is difficult to anticipate ahead of time, but it is achievable through constant testing. Network performance involves an app handling high traffic on slow and weak signals. *Connectivity* requires a plan for alternatives if network access is poor.

Security should include privacy of the user data that must comply with the industry standard. *Testing* should be part of each step of the development process. It should be constant and consistent. Test functionality, performance and interactions on multiple platforms and browsers. *User feedback* whenever requested.

Table 2.1 summarizes the key elements of mobile software quality from the application store using the requirements of the Google Play store as the benchmark.

2.3 ISO/IEC 25010 Quality Standard

According to ISO/IEC 25010:2011, pp. 18–20, 2011, ISO/IEC 25010 is from the ISO/IEC 25000 series of standards known as SQuaRE (System and Software Quality Requirements and Evaluation). The standard has two models, the quality in use model and the product quality model.

The quality in use model has five quality characteristics further subdivided into sub characteristics. The product quality model comprises eight characteristics divided into sub characteristics as depicted in tables 2.1 and 2.2, respectively.

Table 1: ISO/IEC 25010 software product characteristics

Product quality characteristics	Product quality sub-attributes
Functional Suitability	Functional completeness, Functional correctness, functional appropriateness
Compatibility	Co-existence, Interoperability
Usability	Appropriateness recognizability, learnability, operability, User error protection, user interface aesthetics, accessibility
Reliability	Maturity, availability, fault tolerance and recoverability
Security	Confidentiality, integrity, Non-repudiation, Authenticity, accountability

Maintainability	Modularity, reusability, analysability, modifiability, testability
Portability	Adaptability, Installability, replaceability

Table 2. ISO/IEC 25010 Quality in use characteristics

Quality in use characteristics	Quality in use sub-characteristics
Effectiveness	
Efficiency	
Satisfaction	Usefulness, Trust, Pleasure
Freedom from risk	Economic risk mitigation, Health and safety risk mitigation, environmental mitigation
Context coverage	Context completeness, flexibility

3.0 METHODOLOGY

The researcher carried out a quantitative analysis of users' requirements from a mobile app versus the ISO/IEC 25010 quality characteristics outlined in tables 2.1 and 2.2.

4.0 RESEARCH FINDINGS

Table 4.1 shows the features/characteristics of the four stores (Google Play, Apple App, Microsoft and Amazon) surveyed.

Quality requirements of Application Market stores (Researcher, 2021)

S/No.	Feature	Google Play Store	Apple App Store	Microsoft Store	Amazon Store
1	Visual design and interaction	√	√	-	-
2	Functionality	√	-	√	√
3	Compatibility	√	√	√	-
4	Performance	√	-	-	√
5	Stability	√	√	-	-
6	Responsiveness	√	-	-	-
7	Security	√	-	-	√
8	Testing	√	-	-	√

9	Human interface	-	√	-	-
10	Safety	-	√	-	-
11	Design,	-	√	-	-
12	Legality	-	√	-	-
13	Privacy	-	√	√	-
14	Safety	-	-	-	-
15	Usability	-	-	√	√
16	Localization,	-	-	√	-
17	Notifications,	-	-	√	√
18	Content	-	-	√	√
19	Battery efficiency	-	-	√	√
20	Response to customer feedback	-	-	√	√
21	Reliability	-	-	-	√
22	Connectivity	-	-	-	√

Table 4; Quality attributes in detail

Characteristic	Google play store	Apple app store	Windows store	Amazon App store
Compatibility	<ul style="list-style-type: none"> • Compatibility 	<ul style="list-style-type: none"> • Hardware compatibility • Software requirements • App compatibility 	Not included	<ul style="list-style-type: none"> • Not to interfere with core features
Connectivity	<ul style="list-style-type: none"> • Use 2G where possible • Offline working • Storage of data • Queuing requests • Handling images 	Not included	Not included	<ul style="list-style-type: none"> • Alternative plans for lack of network • Security for high traffic and low or weak connections
Security	<ul style="list-style-type: none"> • Privacy of user data and personal information • Data in secure storage • Network to use SSL 	<ul style="list-style-type: none"> • Safety from physical harm • User privacy 	<ul style="list-style-type: none"> • Privacy of users. • User security • Security of function or system 	<ul style="list-style-type: none"> • Security and privacy to comply with the law • Data to be secured on



	<ul style="list-style-type: none"> Libraries to be up to date Review. No javascript enable Execution. App not to dynamically load. Use cryptography. 	<ul style="list-style-type: none"> Data collection and storage Data use and sharing. 	<ul style="list-style-type: none"> the device and network Encryption 	
Content	<ul style="list-style-type: none"> Content should not be harmful Intellectual property 	<ul style="list-style-type: none"> Safe content 	<ul style="list-style-type: none"> No harm Created by the application 	Not included
User support	<ul style="list-style-type: none"> Localization of time and languages 	Not included	<ul style="list-style-type: none"> Engage customers. 	<ul style="list-style-type: none"> Respond to user feedback
Testing	<ul style="list-style-type: none"> Test core suite like navigation Install on SD card Performance and stability Performance monitoring Battery use Security Payments 	Not included	<ul style="list-style-type: none"> Testability required 	<ul style="list-style-type: none"> Testing for each step of the process. Consistent and constant testing

5.0 CONCLUSIONS

This paper surveyed and identified the most relevant quality requirements set up by mobile app stores for mobile app developers to meet to publish their apps.

Four major app stores (Google Play Store, Apple App Store, Microsoft Stores and Amazon Store) were surveyed to accomplish the task by leveraging the ISO/IEC 25010 quality standard using the cross-sectional methodology strategy, thus conducting the study within a limited time frame.

The study found that the relevant quality attributes for mobile applications revolve around Usability, Performance, Maintainability and Support categories.

Based on these attributes, app store owners can ensure that a mobile app can only be published if it meets the required quality attributes.

We recommend conducting a similar study using the longitudinal design since technology is highly dynamic.

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