A STUDY ON QUALITY ASSESSMENT ON MOBILE B2C APPLICATIONS

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ABSTRACT

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This study aims to provide mechanisms to analyze the quality of the Business to Customer (B2C) mobile software products based on mobile-specific characteristics and quality factors, and sub-factors based on ISO 25010 product quality model which would help mobile software developers, designers and testers to develop more effective mobile applications. We aim to help development of more qualified and effective mobile applications from not only developers' perspective but also end-users' perspective. For this purpose, a mixed research method was used to obtain valid and reliable results. Mixed research method consists of the application of questionnaire with 34 software developers, 34 mobile developers, 24 IT experts, and 23 end users who have experienced with B2C mobile applications, and semi-structured interviews with 3 mobile developers, 2 software developers, 3 IT experts, and 2 end users.

Key Words: Software quality model, Mobile Application quality model, ISO 25010

ÖZ

MOBİL B2C UYGULAMALARIN KALİTE DEĞERLENDİRMELERİ ÜZERİNE BİR ÇALIŞMA

YILDIZ, Ekrem

Yüksek Lisans, Bilişim Sistemleri Bölümü

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Eylül 2014, 139 sayfa

Bu çalışmanın amacı B2C mobil uygulamaların kalitesini analiz etmek için bir metod sağlamayı amaçlamaktadır. Bu mekanizmada B2C mobil uygulamalarına özgü özellikler ve ISO 25010 kalite modeline bağlı kalite faktörleri ve alt faktörlerinden yararlanılmıştır. Oluşturulan mekanizma ile mobil geliştirici, tasarımcı ve test uzmanlarına daha etkili mobil uygulama geliştirmelerinde yardımcı olunması amaçlanmıştır. Bu çalışmada daha kaliteli ve etkili mobil uygulamaların geliştirilmesi hem geliştirici hem de son kullanıcı bakış açısıyla oluşturulmuştur. Böyle bir yöntem veya mekanizma geliştirmede, geçerli ve güvenilir sonuçlar almak için karma araştırma yöntemi kullanılmıştır. Karma araştırma yöntemi 34 mobil geliştirici, 34 yazılım geliştirici, 24 BT uzmanı, ve 23 son kullanıcıyla yapılan anket, ve 3 mobil geliştirici, 2 yazılım geliştirici, 3 BT uzmanı, ve 2 son kullanıcıyla görüşmeden oluşmaktadır.

Anahtar Kelimeler: Yazılım Kalite Modeli, Mobil Uygulama Kalite Modeli, ISO 25010

To My Family

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LIST OF ABBREVIATIONS AND TERMS

B2C: Business to Customer

C: Compatibility

EU: End-User

FS: Functional Suitability

ITE: Information Technology Expert

M: Maintainability

MD: Mobile Developer

NAV: Navigation

P: Portability

PE: Performance Efficiency

PRE: Presentation

PUR: Purchasing

R: Reliability

S: Security

SD: Software Developer

U: Usability

CHAPTER 1

INTRODUCTION

Mobile technology is the most common technology with about 6.8 billion subscribers globally which corresponds to 96% of the world population (ICT Data and Statistics Division, 2013). It can be seen that it is more common to have a mobile subscription than having essential needs like electricity and safe drinking water (D. Vision Mobile, 2012). A study by Gartner Group, which is a market research firm, exemplifies that 428 million mobile devices were sold worldwide in first quarter 2011, which was a 19% increase from the previous year (Gartner, 2011). Use of tablet computers is increasing as well, estimated to reach 69.8 % during 2013 (B. Lomas, 2013). The number of smart devices is obviously increasing, so the mobile applications. Gartner reports that 17.7 billion mobile applications were downloaded from applications store worldwide in 2011 and forecast that over 185 billion mobile applications will be downloaded by the end of 2014 (Gartner, 2011). These statistical evidences show how mobile phones and applications have become important in our lives. Nowadays almost everyone has his/her personal phone not only for communication but also for entertainment, complex business processes, and communication over the web and much more. Mannonen, Karhu & Heiskala clarified importance of mobile phones in their study in 2013, describing it as the central communication and computer device in people's everyday life and the most important way to access their ubiquitous and always-changing network of services and information resources which means their personal mobile ecosystem.

Rasheed anticipated in his study that mobile applications market has been accelerating towards a growth rate of around 807% from 2009 ($1.94 billion) to 2013($15.65 billion) (Rasheed, 2012). This rapid growth rate has significantly brought out the need of mobile application development. Thus, this new area brings many opportunities for enterprises and individual developers (Donovan, 2011). As an example, International Data Corporation (IDC) predicts that worldwide mobile apps revenues will surpass $35 billion in 2014 after the number of downloaded apps increases from 10.9 billion in 2010 to 76.9 billion in 2014 (Framingham, 2010). Similarly, Canalys (2011) announces that app store direct revenue will reach $36.7 billion by 2015.

Although there are many opportunities in mobile application development area, there are some challenges too. The quality of mobile applications which affects the speed and performance of mobile applications is one of the biggest challenges for the success of the applications from the users' perspective. Demands on software quality increased rapidly with the rapid growth of mobile applications (Wang, Jiang & Wei, 2012). The applications are expected to be stable, quick and have good user interface (Conder & Darcey, 2010). In order to fulfill these requirements, software developers, designers, testers and quality engineers should be aware of these characteristics that should exists in mobile applications and assure application quality in software development phase.

Developing a mobile application is similar to desktop application development. However, there are some obvious differences between software for mobile devices and desktop software (Conder & Darcey, 2010). The most crucial difference is the way people use them as mobile applications are usually small in size and are designed to use less power. Thus, quality metrics for mobile applications also depends on these factors. Mobile application quality directly affects the user experience so does life time of mobile applications which is much less then desktop application. A user will delete or change the application if it is not according to his needs and perception of quality (Ickin, Wac, Fiedler, Janowski, Hong & Dey, 2012).

This thesis study investigates the most important characteristics and quality factors of Business to Customer (B2C) mobile applications to better understand their effect on the quality of the mobile software.

It is important to note that the results of the study are not expected to provide generalizable method for quality characteristics and factors of all mobile applications. However, the results would provide valuable insights about the most important characteristics and quality factors; differences among both various developers' and end-users' perceptions on quality factors and characteristics, and the relationship between the quality factors that would be considered during development of qualified B2C mobile applications.

This chapter firstly discusses the background, then the problem is stated and the purpose of the study is described. In the following sections, significance of the study is explained and research questions are posed.

1.1 Background of the Problem

Mobile technologies have many significant features that give them an advantage over other information and communication technologies. For example, many mobile devices have wireless communication capability which provides continuous information, and since these devices have small size, low weight and long-life battery power, they are portable and can be used in diverse contexts. The combination of the features of the mobile electronic devices (MEDs) has great impact on the activity in which MEDs are used (Free, Phillips, Felix, Galli, Patel & Edwards, 2010).

Mobile applications are implemented in different domains for several reasons, and the quality of the mobile applications is utilized for variety of goals in mobile software development area. Rahimian and Ramsin (2008) stated important issues for mobile software from the literature like the variety of wireless communication problems, the variety of standards, protocols, the limited capabilities of mobile devices, and privacy. Those issues are some of the factors that affect the quality of mobile applications. Therefore, different methods are developed and used to analyze or measure the quality of the mobile applications. For example, in order to maximize the effectiveness of the PDA-based applications, the solution is data management tasks with minimum text based data entry and high frequency of recording (Yu P. & Yu, H., 2004). Another example is UEAs (Ubicomp Evaluation Areas) which has sample metrics and measures to evaluate ubiquitous computing applications (Scholtz & Consolvo, 2004).

There have been many studies for assessment of quality of the mobile applications for specific goals. However, most of the quality studies are based on software quality models like McCall and ISO 9126. Those quality models do not encompass all the elements of mobile applications especially B2C mobile applications to evaluate the quality. Moreover, the evaluations of mobile applications have been changing with time. Therefore, the assessment mechanism needs to be revised too.

1.2 Statement of the Problem

It has been stated that the development of mobile applications is a challenging task as mobile devices have some technical limitations and specific properties (Abrahamsson, Hanhineva, Hulkko, Ihme, Jäälinoja, Korkala, Koskela & Kyllönen, 2004). Spataru (2010) defined and categorized the limitations of mobile devices that included evolving constraints and inherent constraints which were previously outlined by Hayes (2003). Yamakami also pointed out that the mobile business model had some differences from the desktop software business model (Yamakami 2005, Yamakami 2008). Quality of mobile applications' studies are mainly derived from software quality model studies so far. Commonly, mobile development models underline the necessity of adapting software development practices to the evolving needs of mobile software (Abrahamsson, Warsta, Siponen & Ronkainen, 2003).

There are already some metrics or key features which are used to analyze the quality of mobile applications for specific areas due to the differences of each mobile application's aim. However, it was mentioned that mobile-specific development has been considered with a little attention in the software assurance tasks because of low level criticality of mobile applications (Abrahamsson, Warsta, Siponen & Ronkainen, 2003).

It is important to note that most of the mobile application quality studies have been based on the ISO 9126 quality model which is not valid anymore as the ISO 25010 quality model which has a higher number of quality factors and sub-factors in comparison to ISO 9126 has been published to supersede it.

Moreover, user's perception of the quality which could be seen in ratings and reviews in application market, and high competitiveness of the mobile market brings

about the need for analyzing mobile software products' quality. The mobile application market is enormous and growing which attracts the interests of companies. Companies can get more profit not only by their product which has capabilities of mobile commerce characteristics, but also with advertising and branding activities with the application. While a market value of $3.4 billion in 2010, global mobile and spending is estimated to reach as much as $22.6 till 2016 (Nathan, 2011). International Data Corporation (IDC) also forecasts that mobile application revenue will reach $35 billion in 2014. Moreover, Canalys (2011) predicts that application store revenue will surpass $36.7 billion by 2015. Those results show how big the mobile application market is. Therefore, it becomes crucial to produce effective and qualified mobile applications.

Thus, there is a necessity to assure the quality of the mobile software product by considering both the characteristics and quality factors of mobile applications. Therefore, in order to assess the importance of characteristics and quality factors of mobile applications specifically B2C applications that have not been addressed so far were studied in this research by considering the ISO 25010 quality model.

1.3 Purpose of the Study

One of the purposes of this study is to explore important characteristics, quality factors and sub-factors of B2C mobile applications and to develop a unified method to analyze the quality of those applications which would help mobile software developers, designers and testers to develop more qualified mobile applications specifically for B2C mobile applications.

Secondly, this study tries to find out the differences among participants' perceptions in terms of importance of B2C mobile characteristics and mobile quality factors.

Moreover, this study shows the relationship between defined B2C mobile characteristics and mobile quality factors.

1.4 Significance of the Study

There are several reasons that make the proposed study essential. The first important reason is that it is not obvious how to analyze mobile applications' quality especially for B2C mobile applications. Researchers have used software quality models like proposed by Boehm, McCall and ISO 9126 for the mobile application quality metrics (Behkamal, Kahani & Akbari, 2009; Zahra, Khalid & Javed, 2013; Garofalakis, Stefani, Stefanis & Xenos, 2007). However, such generic and universal models cover much more than the software requirements in the mobile area and it takes a lot of time to extract the parts that fit the needs of developing mobile platforms and applications (Franke, Kowalewski & Weise, 2012).

The second important reason is that ISO 9126 software quality model which is used mostly in evaluation of mobile application quality is not valid anymore as the emerge of the ISO 25010 software quality model in order to make some amendments on the ISO 9126 quality model. Thus, it is crucial to redesign or rearrange mobile applications quality factors based on the latest quality model.

The third important reason is that differences among participants' perceptions were analyzed to define more accurate results in terms of B2C mobile characteristics and quality factors from both developers' and end-users' perspective.

Furthermore, relationship of the B2C mobile application characteristics and mobile quality factors in the provided methodology for this study was examined to identify the importance of the constructs of the model.

In this study, provided methodology will help to analyze the key qualities of mobile software, specifically B2C mobile applications. Moreover, mobile software developer, designer and tester can use it in order to create more qualified mobile applications, which would also help to increase the usage of those applications. Furthermore, stakeholders can make better decisions with the solid knowledge of software quality assurance that positively affect the entire software development process and provide delivering better mobile applications (Shiratuddin & Sarif, 2009). Besides, the constructs defined for B2C mobile application characteristics and mobile quality factors could be used in application market as breakdown items in star rate for application. For instance, end-user can get more realistic information about quality of the application if it has rate for each quality factors such as usability, performance efficiency, and security.

1.5 Research Questions

In the effort to maximize the quality of B2C mobile applications, research questions are listed below;

Research Question 1: ***What are the important characteristics of B2C mobile applications?***

Research Question 2: ***What are the most important quality requirements or factors set for B2C mobile applications?***

Research Question 3: ***What is the difference among Mobile Developers (MD), Software Developers (SD), Information Technology Experts (ITE), and End-Users (EU) based on their perceptions about the B2C mobile application characteristics, quality factors, and sub-factors?***

Research Question 4: ***What is the relationship between the characteristics identified in RQ1?***

Research Question 5: ***What is the relationship between the factors identified in RQ2?***

Research Question 6: ***Do existing mobile application quality models meet the need of B2C mobile application quality?***

The research questions and hypothesis of this study are discussed in detail in Chapter 3.

1.6 Thesis Organization

This thesis has 5 main chapters which are Introduction, Literature Review, Methodology, Results, Discussion and Conclusion.

In the Introduction section, introduction and statement of the problem part presents the reasons to perform this study. In addition, the purpose of the study and the questions answered are stated. Moreover, the significance of the study is discussed.

In the Literature Review section, importance of the mobile application quality, traditional software quality studies, and mobile application quality studies are stated. Moreover, the B2C mobile application quality characteristics and factors are discussed in this part. Furthermore, overview picture of each study is discussed in the literature results part.

The Methodology section contains research design and procedures that are followed for this study. Moreover, participant selection for both quantitative and qualitative phases is discussed. Furthermore, data collection procedures, description of instrument development, and methods of analysis of data are presented.

In the Results chapter, quantitative and qualitative data analysis is presented separately. Moreover, each research question's answer is represented in sub-titles in this section.

The last chapter Discussion and Conclusion discusses the results gathered in the preceding chapter. This thesis is concluded with the suggestions for the future work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to review the literature in order to describe the importance of mobile applications' quality factors that are currently used in practice, and examined in the literature. With the help of the literature review, the importance of mobile applications' quality is better understood. Moreover, different characteristics of those applications and quality studies are discussed. Examining the existing mobile applications and different studies, it is possible to increase the contribution to the research from the related points of views which are gathered.

2.2 Synthesis of the Literature

In this part of the study, the importance of mobile application quality is discussed from the literature. Then, traditional quality studies which are McCall, ISO 25010 Software Quality Model, and other quality studies are mentioned. Later, mobile application quality studies and B2C mobile application quality studies are discussed from the literature.

2.2.1 The Importance of Mobile Application Quality

Before discussing the importance of mobile applications quality in the literature, a brief definition of mobile applications is explored. Mobile applications are meant for mobile devices, tablet PC and other portable media players and are a "lighter version of computer applications" (Awad & El-Shihy, 2014). Yang (2013) describes the mobile apps as "end-user software applications that are designed for a mobile device operating system and which extend that device's capabilities".

Advances in technology provide more improvements for the mobile systems. Therefore, the role of the mobile applications has been increasing in our lives with functionalities that the mobile devices provide. Developing a mobile application is similar to desktop application but there are some certain factors that make mobile apps different from desktop applications (Zahra, Khalid & Javed, 2013). Zahra, Khalid and Javed stated that mobile applications are usually small in size and they use less power since they are designed in that way. These factors are some of the factors that affect the mobile applications quality. Quality of mobile applications is important for several reasons. As for the mobile health applications, it is important to decrease the cost for health and death rate. According to World Health Organization

(WHO), deaths because of the chronic diseases are projected to increase by 17% over the next 10 years (Mechael & Sloninsky, 2008). In other words, 64 million people will die in 2015; 41 million of which will die because of a chronic disease. With the help of more effective smart phone applications, the cost and death rate might be decreased by using health monitoring systems with mobile phones (Kemkar & Dahikar, 2012).

As for the companies, it is important to develop and publish more qualified mobile application that will be accepted by many more end-users. It is expected that the apps market will increase to $14.6 billion by the end of 2012 and reach $36.7 billion by 2015 (Research and Markets, 2011). Moreover, 1 million applications were published and over 50 billion were downloaded in the Google Play store, and over 15 billion applications were downloaded in the Aple Store in 2013(Curran, Mckelvey & Nadarajah, 2014). With more qualified mobile applications, companies can get more profit with their application via number of end-users and advertisements.

In order to increase the quality of the mobile applications, challenges of the mobile devices should be tackled. Developing usable systems for mobile devices have some challenges because of small screen, limited power, ergonomic considerations, and security issues (Bertini, Gabrielli & Kimani, 2006; Jones & Marsden, 2006). Even though there are so many mobile applications developed so far, outcomes related to the use of those applications have been mixed and studies assessing the design and evaluating their effectiveness or quality have been limited (Mechael & Sloninsky, 2008). Thus, analyzing the mobile applications quality has become a popular research area over the past years.

2.2.2 Traditional Quality Studies

As the mobile application development is a new area, most of the quality of mobile application studies is based on the software quality models. The following sections explore these studies in detail.

McCall Software Quality Model

A major contribution to software quality model area was provided by McCall's study which proposed a framework for the measurement of software quality (Cavano & McCall, 1978). It was developed by the US air-force electronic system decision (ESD), the Rome Air Development Center (RADC), and General Electric (GE), with the aim of improving the quality of software products (Behkamal, Kahani & Akbari, 2009). McCall specified that software characteristics should relate directly to mission requirements and serve to define a variety of quality factors: maintainability, reliability, flexibility, correctness, testability, portability, reusability, efficiency, usability, integrity, and interoperability (Cavano & McCall, 1978). Those eleven criteria are grouped into product operations, product revisions, and product transition (Fitzpatrick, 1996). One of the major contributions of the McCall model is the relationship between quality characteristics and metrics (Behkamal, Kahani & Akbari, 2009). However, the authors also stated that functionality of the software

products is not considered by this model, and not all metrics are objective. The McCall's software quality model factors are shown in Table 2.1.

Table 2.1 McCall's Software Quality Model

Study	Dimension	Quality Factors
Cavano and McCall (1978)	Product Revision	Maintainability
		Testability
		Flexibility
	Product Transition	Reusability
		Portability
		Interoperability
	Product Operation	Correctness
		Reliability
		Usability
		Integrity
		Efficiency

ISO 25010 (SQUARE) Software Quality Model

There are many studies published since about 1976 by a number of researchers to define a software quality framework. ISO 25010 standard which is also referred as systems and software quality requirements and evaluation (SQUARE) is based on the earlier form of ISO 9126. According to ISO 9126, quality is defined as a set of features and characteristics of product or service that bears on its ability to satisfy the stated or implied needs (ISO/IEC 9126-1, 2001). Moreover, ISO/IEC 9126 defines a high-level quality attributes in which quality measurements are based on procedures that are recommended in ISO 15999 (ISO, 2007). ISO 9126-1 specifies three models of a software product related to the three views of quality: an internal quality model, an external quality model, and a quality-in-use model (Cheikhi & Abran, 2012).

As for the ISO 25010, SQUARE, it describes the software product quality requirements (ISO, 2007). ISO 25010 consists of two models which are product quality model and quality-in-use model. ISO 25010 defines these two models as:

> *"A product quality model composed of eight characteristics (which are further subdivided into sub characteristics) that relate to static properties of software and dynamic properties of the computer system. The model is applicable to both computer systems and software products"* (ISO 25010, 2007).
>
> *"A quality-in-use model composed of five characteristics (some of which are further subdivided into sub characteristics) that relate to the outcome of interaction when a product is used in a particular context. This system model is applicable to the complete human computer*

system, including both computer systems in use and software products in use" (ISO 25010, 2007).

ISO 25010 quality model presents the software quality attributes in a hierarchical manner (Hamm & Becker, 2011). The quality model divides product quality into characteristics, each of which is composed of several sub-characteristics. The product quality model consists of (1) Functional Suitability, (2) Performance Efficiency, (3) Compatibility, (4) Usability, (5) Reliability, (6) Security, (7) Maintainability, and (8) Portability which are broken down into 31 sub characteristics with a set of internal and external measures to quantitatively assess these quality characteristics (ISO/IEC 25010, 2007). The ISO 25010 software product quality is shown in Figure 2.1.

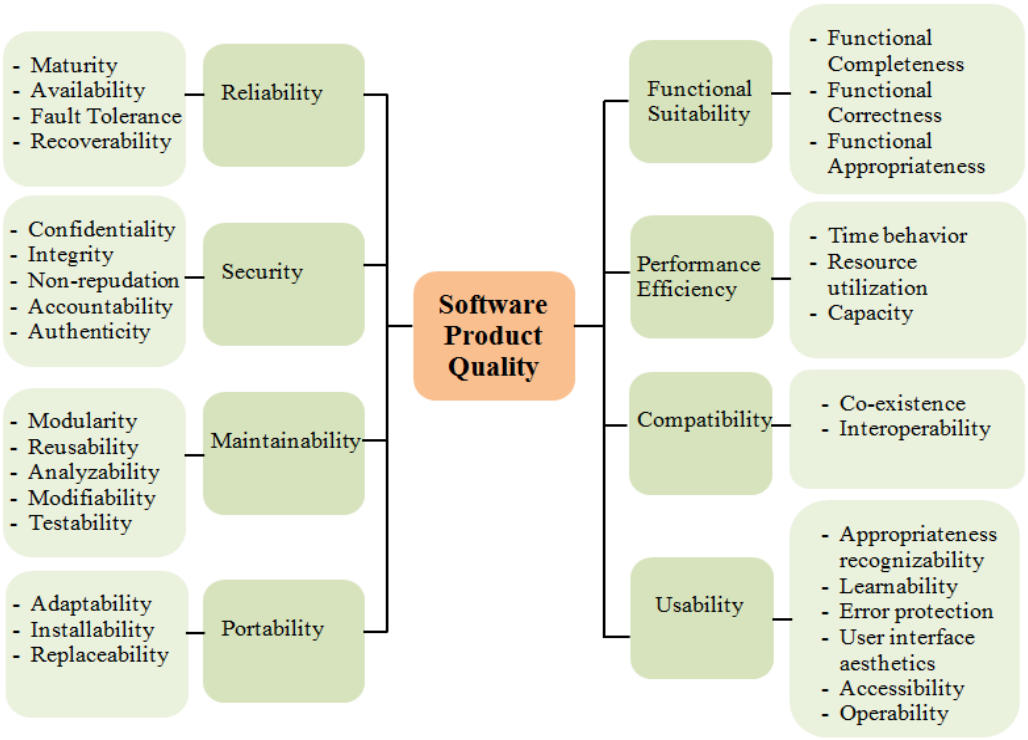

Figure 2.1 ISO/IEC 25010 product quality model (ISO 25010, 2007)

The quality-in-use model has only one level, and includes five characteristics which are (1) Effectiveness, (2) Efficiency, (3) Satisfaction, (4) Freedom from Risk, and (5) Context coverage which are broken down into 11 sub characteristics (ISO/IEC 25010, 2007). ISO 25010 quality in use model is shown in Figure 2.2.

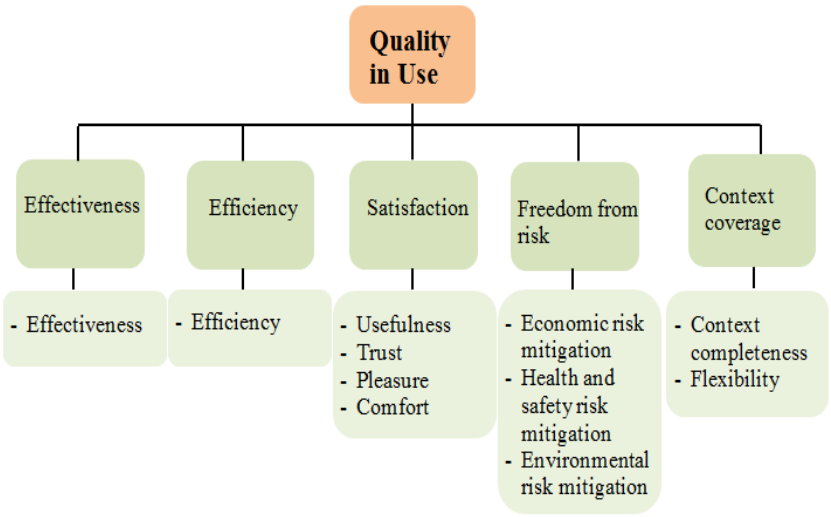

Figure 2.2 ISO/IEC 25010 product quality model (ISO 25010, 2007)

According to Behkamal, Kahani & Akbari (2009), defined characteristics of ISO model are applicable to every kind of software. Moreover, hierarchical structure, universal expressions and terms, simple and exact definitions, and having criteria for evaluation are the most important characteristics of ISO model (Behkamal, Kahani & Akbari, 2009).

ISO 25010 Software Product Quality Factors

Functional Suitability: Functional suitability is *"degree to which a product or system provides functions that meet the stated and implied needs when used under specified conditions"* (ISO 25010, 2007). This quality factor consists of three sub-factors which are functional completeness, functional correctness, and functional appropriateness. Functional completeness means that whether all the functions cover user needs and objectives or not. Functional correctness means that application's results are correct. Functional appropriateness means that applications' functions facilitate the user objectives and needs.

Performance Efficiency: Performance efficiency *is "relative to the amount of resources used under stated conditions"* (ISO 25010, 2007). It consists of three quality sub-factors: Time behavior shows the degree of application's response and processing time. Resource utilization describes the amounts and types of resources which are used by application. Capacity means the maximum limits of application in order to achieve requirements.

Compatibility: Compatibility is *"the degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions, while sharing the same hardware or software environment"* (ISO 25010, 2007). It includes two sub-factors which are co-existence and interoperability. Co-existence means application can perform its functions effectively while sharing common resources with other applications. Interoperability is degree of application's ability to interact with the specified systems.

Usability: Usability is *"degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"* (ISO 25010, 2007). It has six sub-factors: Appropriateness recognizability means that users are aware of the application provides their needs. Learnability shows the degree of users' effort in order to use the application effectively. Operability defines the users' effort for operation and control in the application. User error protection provides users with not making errors. User interface aesthetics shows the degree of attractive and interactive user interface for the user. Accessibility shows that application can be used widest range of people even who have disabilities.

Reliability: Reliability is *"the degree to which a system, product or component performs specified functions under specified conditions for a specified period of time"* (ISO 25010, 2007). Reliability quality factor consists of four sub-factors: Maturity shows that degree of the application provides the needs of reliability. Availability means that application is available and usable when necessary for use. Fault tolerance is the ability of application to cope with any software faults. Recoverability shows the degree of application's recover capability in case of any failure.

Security: Security is *"the degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization"* (ISO 25010, 2007). Security quality factor has five sub-factors: Confidentiality means that application's data is only accessible by users who have access rights. Integrity displays that application prevents unauthorized access. Non-repudiation means actions can be proven in order not to repudiate later. Accountability shows the degree of traceability of any actions that are performed by the user. Authenticity means that any actions that are done by the user in the application could be proven.

Maintainability: It is *"degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers"* (ISO 25010, 2007). It consists of five sub-factors: Modularity is the degree of any changes in one component has minimal impact on other components in the application. Reusability shows the any component of the application can be used in any other component. Analyzability is the effort to find out any bugs or failures and to identify any parts of the application that should be modified. Modifiability means application can be effectively modified without any bugs. Testability shows the effort to validate modification of application

Portability: It is *"the degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another"* (ISO 25010, 2007). It has three sub-factors: Adaptability means that application can be adapted effectively to different environments without any additional effort. Installability defines the users' effort for the installing the application. Replaceability means that application can be changed by another application.

Other Quality Studies

FURPS Model: Robert Grady and Hewlett-Packard Co. proposed that separating software characteristics into two different categories of requirements which are functional requirements and non-functional requirements (Khosravi & Gueheneuc, 2004). Functional requirements are defined by input and expected output. Non-functional requirements consist of usability, reliability, performance and supportability. Although separating functional and non-functional requirements is an advantage to qualify the software, this model does not consider software product's portability (Behkamal, Kahani & Akbari, 2009). The FURPS model's quality factors are shown in Table 2.2.

Table 2.2 FURPS Model Quality Factors

Study	Quality Factors
FURPS (1992)	Functionality
	Usability
	Reliability
	Performance
	Supportability

Boehm Model: This model proposed the same hierarchical structure as McCall's model but also put emphasis on users' expectations and hardware performance (Boehm, Brown, Kaspar, Lipow & MacCleod, 1978). This model consists of three models high-level, intermediate-level, and lower-level (Musa & Alkhateeb, 2013). The quality attributes on Boehm quality standards focuses on portability, reliability, efficiency, human engineering, testability, understandability, and modifiability (Al-Qutaish, 2010). The complexity of Boehm's model is equal to that of McCall's, that is, the quality criteria are related to a variety of quality attributes with relations sharing common attributes (Andreou & Tziakouris, 2006). For this model, including factors which are related to hardware is an advantage; however, it has lack of criteria to measure the quality characteristics (Behkamal, Kahani & Akbari, 2009). The quality factors and dimensions of the Boehm model are shown in Table 2.3.

Table 2.3 Quality Factors and Dimension of Boehm Model

Study	Dimension	Quality Factors
Boehm (1978)	Primary	General Utility
		As is Utility
		Maintainability
	Intermediate	Portability
		Reliability
		Efficiency
		Human Engineering
		Testability
		Understandability
		Modifiability
	Primitive	Device Independence
		Completeness
		Accuracy
		Consistency
		Device Efficiency
		Accessibility
		Communicativeness
		Structuredness
		Self-descriptiveness
		Conciseness
		Legibility
		Augmentability

Dromey Model: It seeks to increase understanding of the relationship between the characteristics and sub-characteristics of quality (Dromey, 1995). It presents four quality categories which are correctness, internal, contextual, and descriptive and each category consists of quality attributes (Musa & Alkhateeb, 2013). The fundamental idea creating this model was to obtain a model broad enough to work for different systems. Even though being applicable to different systems is an advantage of this model, its lack of criteria is a drawback of the model (Behkamal, Kahani & Akbari, 2009). The quality factors and dimensions of the Dromey model are shown in Table 2.4.

Table 2.4 Quality Factors and Dimension of Dromey Model

Study	Dimension	Quality Factors
Dromey (1995)	Correctness	Functionality
		Reliability
	Internal	Maintainability
		Efficiency
		Reliability
	Contextual	Maintainability
		Reusability
		Portability
		Reliability
	Descriptive	Maintainability
		Reusability
		Portability
		Usability

2.2.3 Mobile Application Quality Studies

For mobile application quality, studies have been focused on proposing practices to analyze, measure and test mobile applications in order to assess their quality.

Standard-based mobile application product assessment: Many studies have used and supported the validity of ISO software quality models not only for desktop software applications but also for mobile applications. Hasan, Zahidi, Haider, Hasan and Amin (2012) used six major factors of ISO 9126 in their study to assess the quality attributes of the HTML5 based smart phone applications. Zahra, Khalid and Javed (2013) suggested mobile application quality model with six major characteristics which are functionality, usability, efficiency, maintainability, data integrity and portability, and four sub-characteristics that includes suitability, security, adaptability and extensibility. Moreover, Franke, Kowalewski and Weise (2012) proposed a mobile software quality model using McCall's, Boehm, and ISO 9126 in their research. Stating that developers cannot focus on all qualities, usability, data persistence, efficiency, flexibility that includes adaptability, portability, and extensibility quality characteristics were extracted from these models and applied on two android mobile applications to evaluate the quality of those applications (Franke, Kowalewski & Weise, 2012). From the users' acceptance view, which is directly related to quality in use model extracted from ISO/IEC 2010, application interface design, performance of application, battery efficiency, features of mobile device, application and connectivity cost, user lifestyle, and quality of service are some of the factors that affect any mobile applications' quality (Ickin, Wac, Fiedler, Janowski, Hong & Dey, 2012). Zahra, Khalid and Javed (2013) also mentioned the user acceptance in their study by stating that responsive to user input, fast startup time, and defined purpose are the important characteristic of good mobile application which are highly important for user experience. Furthermore, the authors stated that personalization which provides users to change mobile application according to their requirement should also be taken into account (Zahra, Khalid & Javed, 2013). Hussain and Kutar (2009) also studied the quality of mobile applications from the

users' perspective by only using usability metric which is one of the characteristic of ISO software quality model. The authors proposed three quality characteristics which are effectiveness, efficiency, and satisfaction that are divided into six goals and seventeen usability guidelines to assess the quality of mobile application from the usability perspective (Hussain & Kutar, 2009). Besides, Georgiadis and Stiakakis (2009) stated that their suggested quality criteria which include reliability, assurance, tangibles, empathy, and responsiveness dimensions are compatible with IS0 9126 standard in terms of proper adaptations and interpretations of its characteristics in the mobile services area.

Metric-oriented mobile application product assessment: Ryan and Rossi (2005) proposed a set of metrics to monitor statically source code of mobile applications in order to measure the performance efficiency and quality of the mobile application. As a performance efficiency issue, Pandi and Charaf (2013) proposed a key performance metrics by using resource management as an input to measure the performance of the mobile application. Moreover, the Goal Question Metric (GQM) technique was used for evaluation of usability on mobile applications in order to assess the quality of mobile applications by Hussain and Ferneley (2008).

Test-based mobile application quality assessment: As testing a mobile application is a type of assessing its quality, Franke & Weise (2011) proposed a software quality framework which is based on existing models, metrics, patterns, methods and tools for testing of mobile applications. Wang, Jiang and Wei (2012) also suggested a quality framework to test mobile application by stating that achieving high level user satisfaction and adapting for variety of mobile device are key success factors of a mobile application. Furthermore, Dantas, Marinho, Da Costa & Andrade (2009) proposed a review of testing requirements which includes testing of mobile applications in both emulators and mobile devices, and ensuring the mobile applications must not damage anything that are already developed on the device. Moreover, an adaptive random test case generation technique was proposed to produce black-box test cases for mobile applications (Liu, Gao & Long, 2010).

A literature summary of the mobile application quality studies in terms of quality characteristics or factors and dimension are shown in Table 2.5.

Table 2.5 A Summary of the Literature on Mobile Application Quality

Study	Dimension	Quality Characteristics / Factors
Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012)	Quality of Service	Application Interface Design
		Application Performance
		Battery Efficiency
		Phone Features
		Application and Connectivity Cost
		User Routines and Lifestyle
	Quality of	
Hasan, Zahidi, Haider, Hasan & Amin (2012)		Efficiency
		Maintainability
		Reliability
		Functionality
		Usability
		Portability
Zahra, Khalid and Javed (2013)		Maintainability (Adaptability,
		Data Integrity
		Usability
		Functionality (Suitability, Security)
		Efficiency
		Portability
Franke, Kowalewski & Weise (2012)		Application Interface's Design
		Application Performance
		Battery
		Phone Features
		Applications and Data Connectivity
		User Routines
		User Lifestyle
Franke & Weise (2011)		Flexibility
		Adaptability
		Data persistence
Georgiadis & Stiakakis (2009)	Reliability	Information accuracy
		Correct functioning
	Assurance	Customer Confidence
		Security
	Tangibles	Design
		Use of Technologies
	Empathy	Customization
		Accessibility
	Responsiveness	Prompt response
		Customer service

Business-to-Customer (B2C) Mobile Application Quality

Mobile applications provide not only an opportunity for advertising and branding but also for mobile commerce channel. According to Nielsen (2010), almost 21% of the smartphone owners reported using shopping and retail applications during the preceding 30 days. Nielsen finds that games which are in mobile entertainment service are the most popular applications followed by weather, navigation and social networking. Thus, mobile applications represent an emerging technology in the marketplace. There are several types of B2C mobile applications which include mobile financial applications, mobile advertising, mobile inventory management, product locating and shopping, proactive service management, mobile entertainment services and games, mobile distance education (Varshney & Vetter, 2001).

Examples of some types of B2C mobile applications are:

- Mobile Financial Applications: Applications that are used in financial area such as banking, payments for mobile users.
- Mobile Advertising: Applications that are used for marketing area. User specific and location sensitive advertisements are the examples.
- Mobile Inventory Management: Applications provide to reduce the amount of inventory needed by managing in-house and inventory on move such as location tracking of goods.
- Proactive Service Management: Users can get information on services that they will need in near future from applications. For instance, vendors can gather the information related to aging components.
- Mobile Entertainment Services and Games: Applications provides the entertainment services to the users like video on demand, audio on demand, and interactive games.
- Mobile Office: Mobile works can get complete office environment by those types of applications. Working from traffic jams, airport and conferences are some of the examples.
- Mobile Distance Education: Applications enable users to get virtual education support anytime and anywhere.
- Wireless Data Center: Vendors can download detailed information on one or more products.

As the range of the B2C mobile application area is wide, quality of those applications became important. Moreover, organizations are aware of the need for good quality applications to reach more success in the rapidly growing e-commerce market (Behkamal, Kahani & Akbari, 2009) which is directly related to mobile commerce market. As a business process, mobile commerce is considered as a particular type of e-commerce (Coursaris & Hassanein, 2002). Lian (2010) also mention that mobile

commerce is viewed as part of the electronic commerce. A widespread and comprehensive definition of m-commerce is given by Turban (2004), and it is defined as a monetary transaction for goods and services produced by a mobile device which has an operating system specific to mobile devices and a mobile-dedicated infrastructure.

In order to better assess quality studies of the B2C mobile applications the next part of the present study discusses the characteristics and quality factors of business to customer mobile applications.

B2C Mobile Application Quality Characteristics and Factors

Garofalaki, Stefani, Stefanis and Xenos (2007) evaluated the B2C mobile applications with four quality attributes, which are functionality, usability, reliability and efficiency, with three characteristic dimensions of m-commerce systems which are (1) **presentation** which describes how a product is shown to the end user, (2) **navigation** which includes the variety of mechanisms to the user for accessing information and services of the mobile commerce system, and (3) **purchasing** which refers to commercial transaction facilities. The authors answered the question whether m-commerce system can be both well designed and with high quality or not. Gupta and Madan extended (2011) Garofalaki, Stefani, Stefanis, & Xenos study's by adding two more quality characteristics which are maintainability and portability, and also defined the security attributes, which includes confidentiality, security mechanism, replay attack prevention, that affect the quality of business-to-customer mobile application.

Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005) are the ones who were exploring both the key design and development factors of mobile commerce applications in their study by mentioning dimensions which are technical issues affecting the quality and user requirements from the consumer's satisfaction perspective. The authors stated in their study that interference, low bandwidth, high delays and large delay variation, lower security, frequent disconnections were listed as key technical issues which influence the performance of mobile applications and ubiquity, personalization, flexibility, and localization are the key user requirements to assess the mobile consumer's satisfaction (Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas, 2005). Andreou, Panayidou,and Pitsillides (2005) refined and enhanced Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas' study which was called as Mobe study and proposed the quality model with six general characteristics which are functionality, reliability, usability, efficiency, maintainability and portability and 18 sub characteristics.

A summary of the literature on B2C mobile application quality studies in terms of quality characteristics or factors and dimension is shown in Table 2.6.

Table 2.6 A Summary of the Literature on B2C Mobile Application Quality

Study	Dimension	Quality Characteristics / Factors
Garofalaki, Stefani, Stefanis, & Xenos (2007)	Purchasing	Functionality
		Usability
		Reliability
		Efficiency
	Navigation	Functionality
		Usability
		Reliability
		Efficiency
	Presentation	Functionality
		Usability
		Reliability
		Efficiency
Gupta & Madan (2011)	Purchasing	Functionality
		Usability
		Reliability
		Efficiency
		Maintainability
		Portability
	Navigation	Functionality
		Usability
		Reliability
		Efficiency
		Maintainability
		Portability
	Presentation	Functionality
		Usability
		Reliability
		Efficiency
		Maintainability
		Portability
Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)	Technical issues	Interference
		Low bandwidth
		High delays and large delay variation
		Lower security
		Frequent Disconnections
	User Requirements	Ubiquity
		Personalization
		Flexibility
		Localization
Andreou, Panayiodu, Andreou, & Pitsillides (2005)		Functionality
		Reliability
		Usability
		Efficiency
		Maintainability
		Portability

2.3 Conclusion/Summary

This section has presented a literature review of the mobile application quality factors. Firstly, brief explanations of the concepts in the literature were provided. Next, the importance of mobile applications' quality is discussed. Later, traditional quality studies, mobile applications quality studies and B2C mobile application studies were overviewed. With this review, an insight on the placement of the study within the existing literature has been provided. Moreover, the purpose and significance of the study indicated in the previous chapter are supported by synthesis of the literature.

2.4 Implications

The quality of B2C mobile applications might increase profit of a company with more end-users and advertisements. In order to construct these qualified mobile applications some methods should be developed and then considered by mobile software developer, designer and tester in the development process. Most importantly, further research might be conducted to measure other mobile applications' quality by using the proposed method of this study.

2.5 Literature Summary

In Figure 2.3, the results from the literature are schematically represented to provide an overview picture from the literature on mentioned topics in this chapter. Moreover, each of the study's quality characteristics or factors discussed in this chapter is represented in Table 2.7 to show the number of each quality characteristic and factor from the studies.

Results from the literature show that B2C mobile application quality is an important issue considering the mobile application market value. There are different methods used by mobile application developers and quality assurance teams but most of them has lack of criteria and based on ISO 9126 quality model which has been superseded by ISO 25010 quality model.

For qualified mobile application development, not only developers and quality assurance teams' criteria but also the end users' expectations must be considered. Moreover, quality factors that are considered by the developers and quality assurance teams should be widened for the improvement of software quality models.

In this research, Garofalaki, Stefani, Stefanis and Xenos' study was revised to define B2C mobile application characteristics, and ISO 25010 software quality model factors was used to understand which quality factors and sub-factors are important for Software Developers (SD), Mobile Developers (MD), Information Technology Experts (ITE) and End-Users (EU).

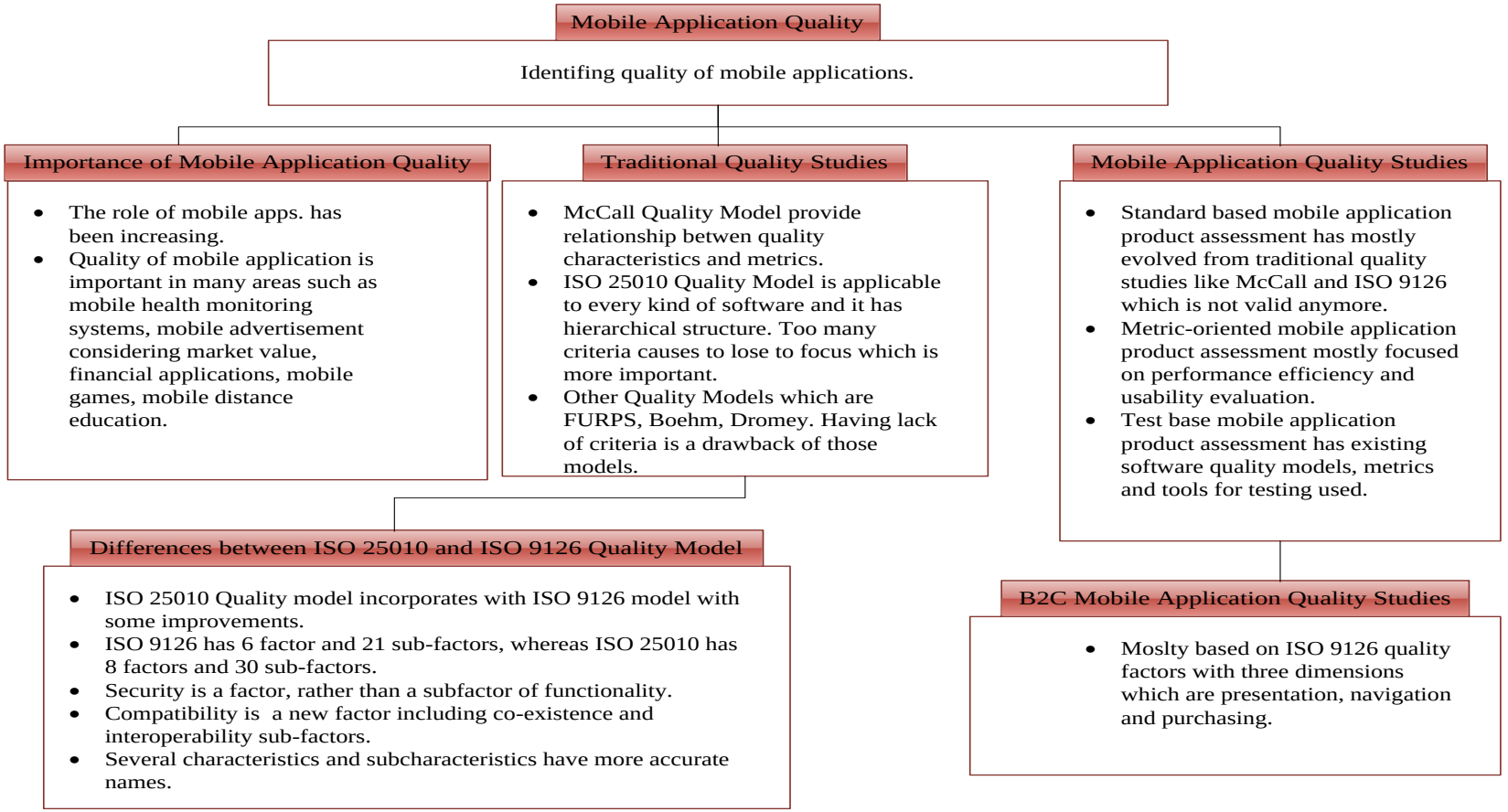

Figure 2.3 Literature Review Results

Table 2.7 References of Quality Characteristics / Factors

Quality Characteristics / Factors	**References**
Accessibility	Boehm (1978) ; Georgiadis & Stiakakis (2009)
Accuracy	Boehm (1978)
Adaptability	Franke & Weise (2011)
Application and Connectivity Cost	Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012) ; Franke, Kowalewski & Weise (2012)
Application Interface Design	Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012) ; Franke, Kowalewski & Weise (2012)
Application Performance	Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012) ; Franke, Kowalewski & Weise (2012)
As is Utility	Boehm (1978)
Augmentability	Boehm (1978)
Battery Efficiency	Franke, Kowalewski & Weise (2012) ; Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012)
Communicativeness	Boehm (1978)
Compatibility	ISO 25010 (2007)
Completeness	Boehm (1978)
Conciseness	Boehm (1978)
Consistency	Boehm (1978)
Context coverage	ISO 25010 (2007)
Correct functioning	Georgiadis & Stiakakis (2009)
Correctness	Cavano and McCall (1978)
Customer Confidence	Georgiadis & Stiakakis (2009)

Quality Characteristics / Factors	**References**
Customer service	Georgiadis & Stiakakis (2009)
Customization	Georgiadis & Stiakakis (2009)
Data Integrity	Zahra, Khalid and Javed (2013)
Data persistence	Franke & Weise (2011)
Design	Georgiadis & Stiakakis (2009)
Device Efficiency	Boehm (1978)
Device Independence	Boehm (1978)
Effectiveness	ISO 25010 (2007)
Efficiency	Boehm (1978) ; Cavano and McCall (1978) ; Dromey(1995) ; ISO 25010 (2007) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Zahra, Khalid and Javed (2013) ; Garofalaki, Stefani, Stefanis, & Xenos (2007) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005)
Flexibility	Cavano and McCall (1978) ; Franke & Weise (2011) ; Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Freedom from risk	ISO 25010 (2007)
Frequent Disconnections	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Functional Suitability	ISO 25010 (2007)
Functionality	Dromey(1995) ; FURPS (1992) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Zahra, Khalid and Javed (2013) ; Garofalaki, Stefani, Stefanis, & Xenos (2007) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005)
General Utility	Boehm (1978)
High delays and large delay variation	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Human Engineering	Boehm (1978)
Information accuracy	Georgiadis & Stiakakis (2009)

Quality Characteristics / Factors	References
Integrity	Cavano and McCall (1978)
Interference	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Interoperability	Cavano and McCall (1978)
Legibility	Boehm (1978)
Localization	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Low bandwidth	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Lower security	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Maintainability	Cavano and McCall (1978) ; Boehm (1978) ; Dromey(1995) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Zahra, Khalid and Javed (2013) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005) ; ISO 25010 (2007)
Modifiability	Boehm (1978)
Performance	FURPS (1992)
Performance Efficiency	ISO 25010 (2007)
Personalization	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Phone Features	Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012) ; Franke, Kowalewski & Weise (2012)
Portability	Cavano and McCall (1978) ; Boehm (1978) ; Dromey(1995) ; ISO 25010 (2007) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Zahra, Khalid and Javed (2013) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005)
Prompt response	Georgiadis & Stiakakis (2009)
Reliability	Cavano and McCall (1978) ; Boehm (1978) ; Dromey(1995) ; FURPS (1992) ; ISO 25010 (2007) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Garofalaki, Stefani, Stefanis, & Xenos (2007) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005)

Quality Characteristics / Factors	**References**
Reusability	Cavano and McCall (1978); Dromey(1995)
Satisfaction	ISO 25010(2007)
Security	ISO 25010 (2007) ; Georgiadis & Stiakakis (2009)
Self-descriptiveness	Boehm (1978)
Structuredness	Boehm (1978)
Supportability	FURPS (1992)
Testability	Cavano and McCall (1978) ; Boehm (1978)
Ubiquity	Andreou, Leonidou, Chrysostomou, Pitsillides, Samaras, and Schizas (2005)
Understandability	Boehm (1978)
Usability	Cavano and McCall (1978) ; Dromey(1995) ; FURPS (1992) ; ISO 25010 (2007) ; Hasan, Zahidi, Haider, Hasan & Amin (2012) ; Zahra, Khalid and Javed (2013) ; Garofalaki, Stefani, Stefanis, & Xenos (2007) ; Gupta & Madan (2011) ; Andreou, Panayiodu, Andreou, & Pitsillides (2005)
Use of Technologies	Georgiadis & Stiakakis (2009)
User Routines and Lifestyle	Ickin, Wac, Fiedler, Janowski, Hong & Dey (2012) ; Franke, Kowalewski & Weise (2012)

CHAPTER 3

METHODOLOGY

In the light of the information provided in the previous chapters that includes purpose and significance of the study, and literature review in the related field, this chapter describes the methodology that will be followed while conducting the study. Moreover, this chapter discusses the research questions, research design and procedures, population and sampling, data collection procedures and instrumentation, data analysis, and limitations of the study.

3.1 Research Questions & Research Hypothesis

The purpose of this study is to analyze the quality of the B2C mobile applications through characteristics and quality factors of B2C mobile applications that help the mobile software developers, designers and testers to build more effective and qualified B2C mobile applications. Moreover, the relationships of the model's constructs are examined with the research hypothesis to answer RQ4 and RQ5.

In accordance with the purpose of the study, the following research questions are studied;

Research Question 1: ***What are the important characteristics of B2C mobile applications?***

Research Question 2: ***What are the most important quality requirements or factors set for B2C mobile applications?***

As the participants of this study have different background in terms of their occupation, RQ3 was defined to search for differences among them;

Research Question 3: ***What is the difference among Mobile Developers (MD), Software Developers (SD), Information Technology Experts (ITE), and End-Users (EU) based on their perceptions about the B2C mobile application characteristics, quality factors, and sub-factors?***

In order to analyze the relationship of the characteristics of B2C mobile applications, RQ4 was defined;

Research Question 4: ***What is the relationship between the characteristics identified in RQ1?***

To answer the RQ4, research hypothesis which are shown below for the B2C mobile application characteristics were conducted.

Considering the mobile devices capabilities in terms of limited screen size, Navigation is an important construct that can affect the users' perception on presentation and purchasing constructs. Therefore H1 and H2 were defined to answer the relationship between Navigation and Presentation, and Navigation and Purchasing constructs.

H1. Navigation (NAV) construct has a positive influence on Presentation (PRE) construct.

H2. Navigation (NAV) construct has a positive influence on Purchasing (PUR) construct.

As Presentation is another important construct that can affect the users perception on purchasing construct, H3 were defined to answer the relationship between Presentation and Purchasing.

H3. Presentation (PRE) construct has a positive influence on Purchasing (PUR) construct.

As for the relationship of the quality factors, RQ5 was defined;

Research Question 5: ***What is the relationship between the factors identified in RQ2?***

To answer the RQ5, research hypotheses which are shown below for the B2C mobile application factors were posed.

Maintainability which provides to improve the system if there is any change request or update is an important quality factor. Therefore, any change can directly influence on other constructs. Thus, H4..H10 were defined to answer the relationship Maintainability constructs with other constructs.

H4. Maintainability (M) construct has a positive influence on Usability (U) construct.

H5. Maintainability (M) construct has a positive influence on Security (S) construct.

H6. Maintainability (M) construct has a positive influence on Performance Efficiency (PE) construct.

H7. Maintainability (M) construct has a positive influence on Portability (P) construct.

H8. Maintainability (M) construct has a positive influence on Reliability (R) construct.

H9. Maintainability (M) construct has a positive influence on Compatibility (C) construct.

H10. Maintainability (M) construct has a positive influence on Functional Suitability (FS) construct.

As mentioned in B2C characteristics, usability is an important quality factor considering the mobile devices capabilities. If the application is easy to use, it can affect the users' perception on all quality factor constructs. Therefore, H11..H16 were defined to answer the relationship Usability constructs with other constructs.

H11. Usability (U) construct has a positive influence on Security (S) construct.

H12. Usability (U) construct has a positive influence on Performance Efficiency (PE) construct.

H13. Usability (U) construct has a positive influence on Functional Suitability (FS) construct.

H14. Usability (U) construct has a positive influence on Portability (P) construct.

H15. Usability (U) construct has a positive influence on Reliability (R) construct.

H16. Usability (U) construct has a positive influence on Compatibility (C) construct.

RQ6 was proposed to explore another purpose of this study as given below;

Research Question 6: ***Do existing mobile application quality models meet the need of B2C mobile application quality?***

3.2 Research Design and Procedures

The research design which was followed for this study is both qualitative and quantitative research referred as the mixed method. According to Creswell (2009), research method proposals have three main phases that include data collection, analysis, and interpretation. In order to get the answers of the research questions of the study, a researcher should select an appropriate research design methodology, which are quantitative, qualitative or mixed methods.

The use of quantitative and qualitative approaches together provides a better understanding of the research problems with respect to using one approach alone (Creswell & Clark, 2011). In order to describe research problem in a detailed way or when more data is required, mixed method studies can be conducted (Creswell, 2012). Mixed methods research paradigm is explained in several books (Brewer & Hunter, 1989; Creswell, 2003; Greene, Caracelli & Graham, 1989; Johnson & Christensen, 2004; Newman & Benz, 1998; Reichardt & Rallis, 1994; Tashakkori & Teddlie, 2003). Mixed methods provide an alternative perspective within a research problem (Greene, Caracelli & Graham, 1989). The main aim of this study was to discover most important characteristics and quality factors of B2C mobile applications. In order to address the research questions in a more detailed way, a mixed method research design was used in the study.

There are three major mixed-method design types which are explanatory design, exploratory design, and triangulation design, that each includes a combination of qualitative and quantitative data (Fraenkel, Wallen & Hyun, 2012). However, Creswell (2008) divided mixed method strategies into six categories which are the sequential explanatory strategy, sequential exploratory strategy, sequential transformative strategy, concurrent triangulation strategy, concurrent nested strategy, and concurrent transformative strategy. As to address the research questions in this study, sequential explanatory strategy was used. Figure 3.1 shows the research design of the study. At the first phase which includes online survey, quantitative results were described and clarified. For the second phase which includes semi-structured interview, qualitative data were collected and analyzed.

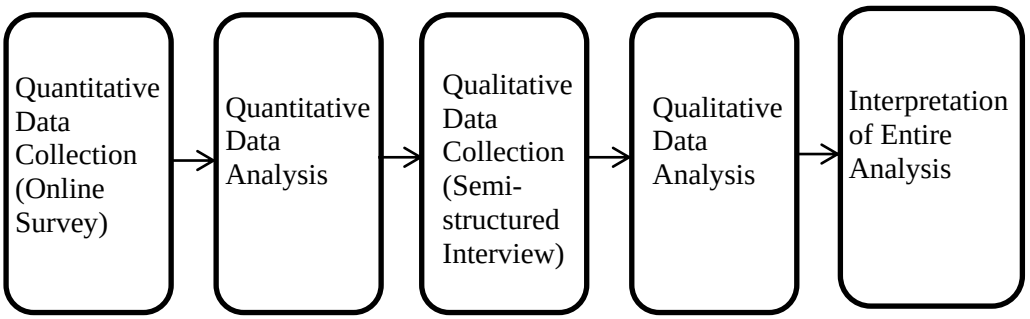

Figure 3. 1 Research Design of the Study

Creswell (2008) explained that sequential explanatory strategy is used to clarify and interpret the quantitative data which are followed by collection and analysis of qualitative data. Furthermore, the straightforward nature of the strategy which makes it a popular strategy for mixed methods design provides the implementation easily as steps are clear (Creswell, 2008).

This study was performed in two phases as a mixed method design. In mixed method design, quantitative and qualitative data could be collected separately in two phases with the purpose of enhancing and fulfilling one of the sources by getting data from the other source (Greene, Caracelli & Graham, 1989). Due

to the model of the study which is sequential mixed method, quantitative data was gathered and analyzed in the online survey phase which is shown in Figure 3.3. After the first phase, qualitative data collection and analysis were done in the semi-structured interview phase as shown in Figure 3.4. When the first and second phase were conducted, the data gathered from both quantitative and qualitative methods were integrated and interpreted in order to present the results as shown in Figure 3.2.

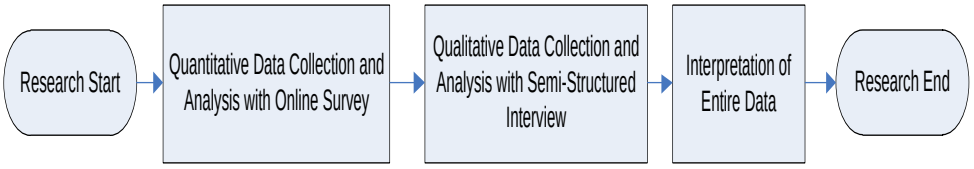

Figure 3.2 Flowchart of the Study

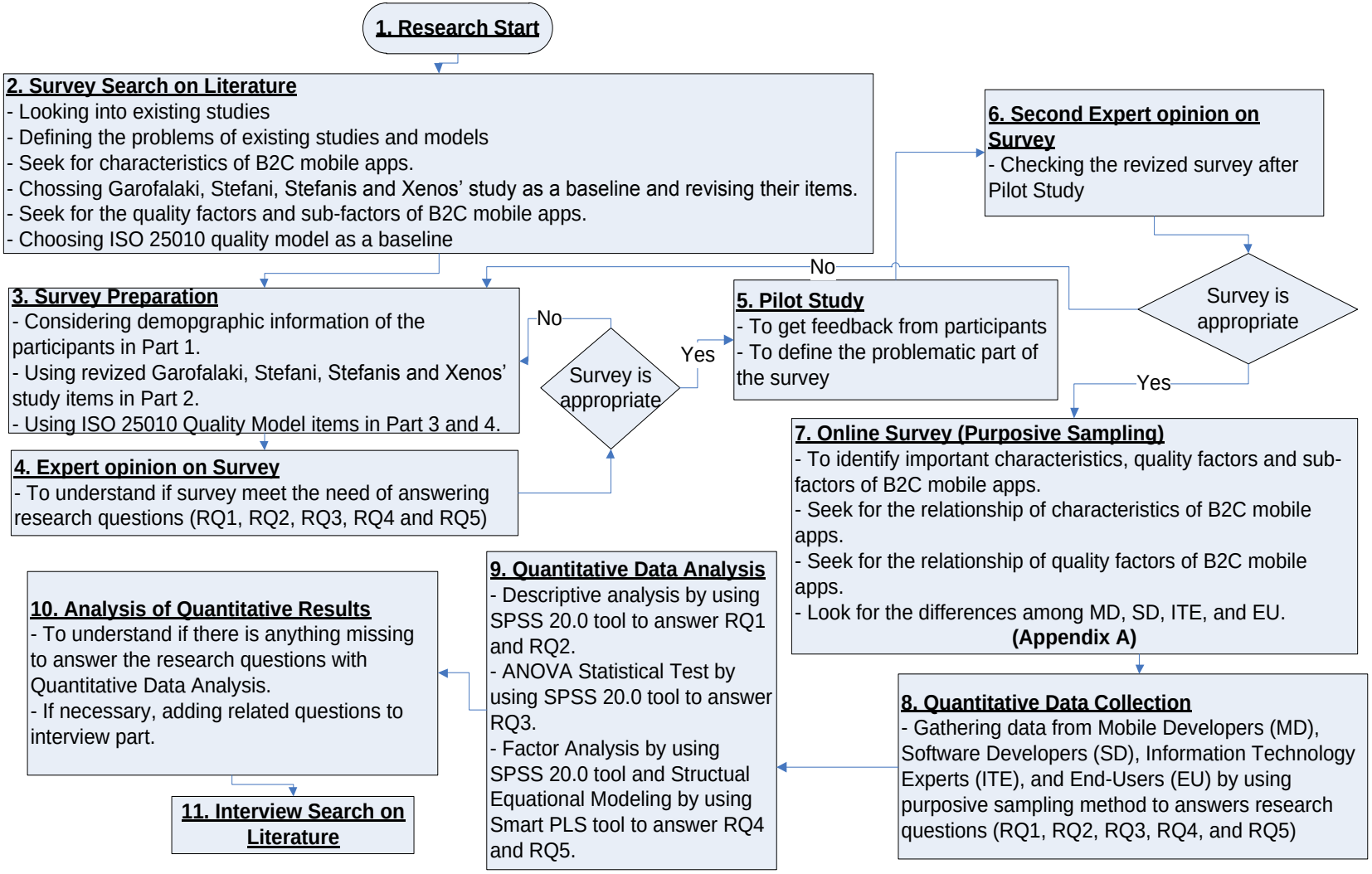

Figure 3.3 Flowchart of Research Method for Online Survey

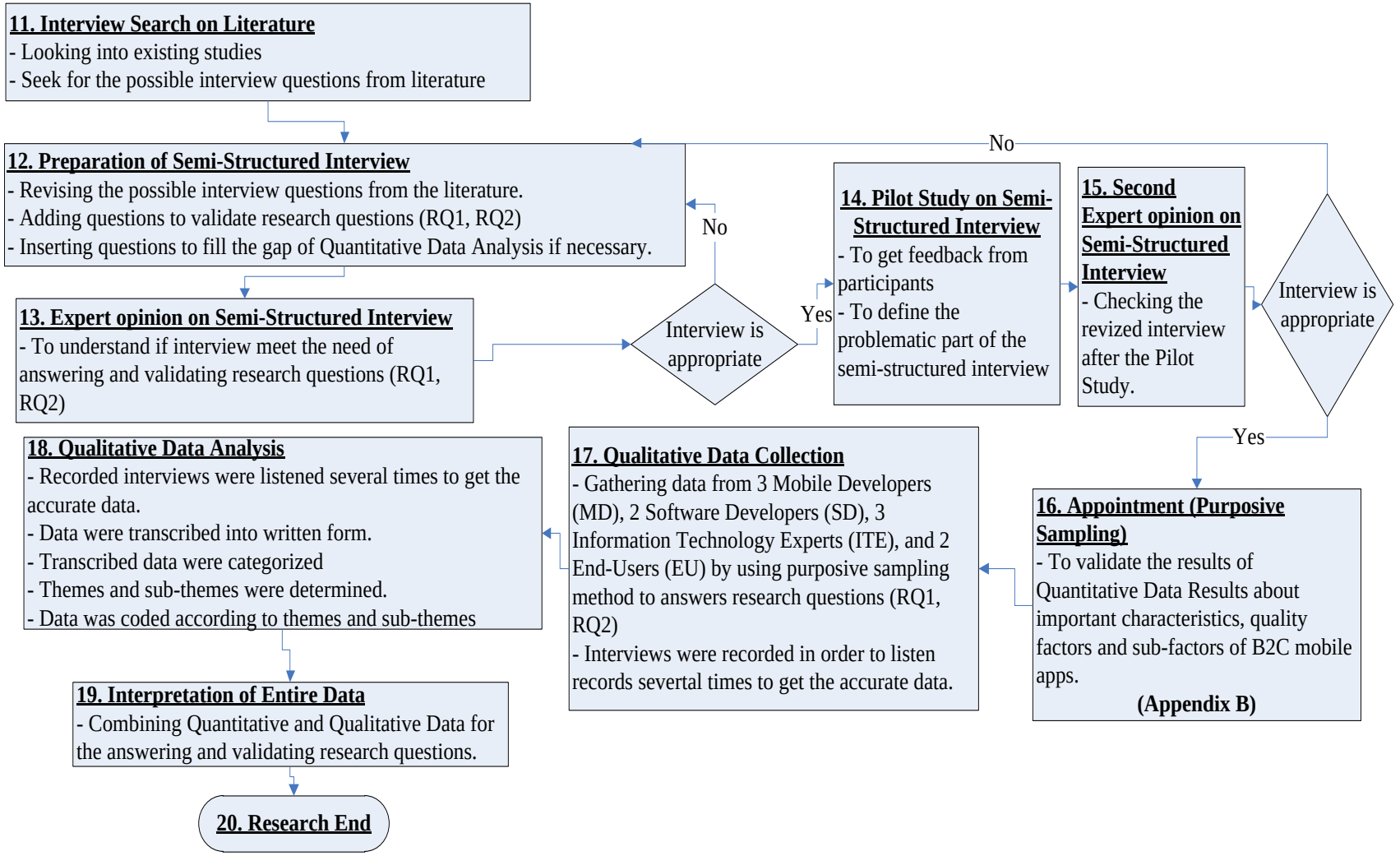

Figure 3.4 Flowchart of Research Method for Semi-Structured Interview

3.3 Research Population and Sampling

The subjects of this research were mobile application developers, software developers, information technology experts, and end users who had experience with B2C mobile applications. When the research has specific purpose, researcher might use purposive sampling which is different from convenience sampling where researchers do not simply study whoever is available (Fraenkel, Wallen & Hyun, 2012). Purposive sampling which is also called confirmatory sampling is a non-probability sampling procedure where participants are selected on the basis of their consistency with the purpose of the study (Daniel, 2011). This study was carried out by using purposive sampling for both quantitative and qualitative phases.

In order to carry out the quantitative phase of the study, a survey which has four parts was conducted. In view of the fact that sample should present similar characteristics of the target population, selecting as large sample as possible is important (Creswell, 2012). To conduct the survey, the questionnaire was converted to an online survey in order to reach more potential participants.

In order to collect qualitative data, semi-structured interview was used in the qualitative phase. Purposive sampling was used in qualitative phase like quantitative phase. The interviewee candidates were chosen from the survey participants. Considering the knowledge of each candidate about the B2C mobile application area, interviewee candidates were chosen. To determine the interviewee candidates, first of all quantitative data were analyzed. As the aim of interview is to get deeper understanding, expert level participants who were mobile application developers, software developers, IT experts and end-users were selected. The reason why not only mobile application or software developer was selected is to get idea from user perspective. Hong (2008) stated that a user perspective of quality is important instead of developer perspective. 10 were agreed to participate in the interview. 3 of the participants were mobile application developers, 2 of them software developers, 3 of them IT experts, and 2 of them are end-users.

Overall, the study had 115 participants. Proportions of the participants both the quantitative and qualitative parts are shown in Table 3.1

Table 3.1 Proportions of Participants by Title and Gender

Participant Groups	**Survey Study**			**Interview**		
	Female	**Male**	**Total**	**Female**	**Male**	**Total**
Mobile Developer	3	31	34	-	3	3
Software Developer	1	33	34	-	2	2
IT Expert (ITE)	2	22	24	-	3	3
End-User (EU)	5	18	23	-	2	2
Total	11	104	115	-	10	10

Details of each quantitative and qualitative phases are given separately in next part.

3.3.1 Survey Demographics

In this section, gender, job title, experience years, and age of the participants are presented in Table 3.2.

Table 3.2 Participants of Questionnaire Study

		Frequency (n=115)	**%**
Gender	Female	11	9,6
	Male	104	90,4
Title	Mobile Developer (MD)	34	29,6
	Software Developer (SD)	34	29,6
	Information Technology Expert (ITE)	24	20,9
	End-user (EU)	23	20
Years of Experience	0-1 year	6	5,2
	1-3 years	37	32,2
	3 + years	72	62,6
Age Groups	21-26	39	33,9
	27-32	55	47,8
	33-38	15	13,0
	39-43	6	5,2

Of the 115 respondents, 11 (9,6%) were female and 104 (90,4%) were male, and have different job titles.

As seen from Table 3.2, from 115 respondents, 34 (29,6%) were mobile developers, 34 (29,6%) were software developers, 24 (20,9%) were information technology experts, 23 (20%) were end-users that include IT project manager, research assistants, banker, teacher, and senior executives. Participants who defined the job title as others or end-users part are presented in Table 3.3.

Table 3.3 Participants Distribution by End-Users Job Title

		Frequency (n=23)	**%**
End-users	IT Project Manager	11	47.8
	Research Assistant	4	17.4
	Senior Executive	4	17.4
	Banker	1	4.3
	Teacher	1	4.3
	Human Resources Expert	1	4.3
	Unspecified	1	4.3

From 115 respondents, 6 (5,2%) has 0-1 year working experience, 37(32,2%) has 1-3 years working experience, and 72(62,6%) has 3+ years working experience. The average age of the sample was 28.8 years. In terms of age groups, the largest group was in between 27-32 (47,8%).

Even though the respondents were from various departments, the most of the participants were from engineering departments or computer science related area as purposive sampling was chosen as a strategy. The participants' distribution by department is presented in Table 3.4.

Table 3.4 Participants Distribution by Departments

Departments	Frequency	%
Computer Engineering	42	36.5
Biology	1	0.9
Business Administration	4	3.5
Civil Engineering	1	0.9
Computer Education and Instructional Technology	28	24.3
Computer Programming	10	8.7
Computer Technology & Information Systems	1	0.9
Electrical and Electronics Engineering	7	6.1
Electronics and Communication Engineering	1	0.9
Industrial Engineering	4	3.5
Information Systems	2	1.7
Information Technologies	1	0.9
International Computer Institute	1	0.9
Mathematics	2	1.7
Mathematics & Computer Science	1	0.9
Mechanical Engineering	2	1.7
Physics Engineering	1	0.9
Public Administration	1	0.9
Social Sciences Education	1	0.9
Software Engineering	1	0.9
Software Management	1	0.9
Statistics	1	0.9
Teacher Training in Computer and Control	1	0.9
Total	**115**	**100**

3.3.2 Interview Demographics

For the quantitative phase of the study, 10 participants from different job titles were participated in the semi-structured interview. The distribution of the interviewees is shown in Table 3.5. The average duration of the interviews was approximately 21 minutes. Three of the interviewees were Mobile Developers, two were Software Developers, three were IT Experts, and two were End-Users who are especially

project managers. While the average age of the participants was 29, the average years of experience was 8.9 years.

Table 3.5 Distribution of Interviewees

		Frequency	%
Gender	Female	0	0.0
	Male	10	100.
Title	Mobile Developer (MD)	3	30.0
	Software Developer (SD)	2	20.0
	Information Technology Expert (ITE)	3	30.0
	End-user (EU)	2	20.0
Years of Experience	1-3 years	2	20.0
	3 + years	8	80.0
Age Groups	21-27	3	30.0
	28-34	5	50.0
	34-40	2	20.0

As purposive sampling method used in the interview like the survey, all of the participants were graduated from Computer Science or Engineering Departments except one who has been working 10 years as information technology expert.

3.4 Data Collection Procedures and Instrumentation

This study has combination of both quantitative and qualitative data collection procedures due to the mixed research design. With the help of the mixed research design, it is much easier to get more detailed and understandable data. As stated before, different types of data collection procedures and instruments were used for each phase of the study. As for quantitative phase, an online survey was conducted as a quantitative study. In qualitative phase, semi-structured interview was used to get qualitative data to validate the quantitative phase.

3.4.1 Survey

Robson (2002) defined survey as it is "the collection of the standardized information from a specific population". Moreover, Fraenkel, Wallen & Hyun (2012) stated that survey provides to explain the characteristics of a population. In order to gather data, an online questionnaire which provides the participants reaching the instrument via computers using internet was prepared. Online surveys provide to get extensive data quickly by reaching as many subjects as possible (Creswell, 2012).

The questionnaire used in this study has four parts which are demographic information about participants, the importance degree of B2C mobile applications' characteristics, the importance degree of B2C mobile application quality factors, and the importance degree of B2C mobile application quality sub-factors. In order to get the importance degree of the B2C mobile applications' characteristics, quality factors, and quality sub-factors six point Likert scale which prevents the collection of data in the middle considering five point Likert scale was used. Moreover, in order to

reduce the missing value for the online survey, most of the questions were required questions. However, even if the participant has no idea about a question, this scale forces the participant to choose a wrong option. To prevent this situation, "no idea" option in the online survey was added for each question.

Demographic Information about Participants: This part of the questionnaire has seven items in order to get nominal and interval data. Age, gender, university, department, job title, years of work experience, and e-mail address of the participants were asked in this part of the questionnaire.

Importance Degree of B2C Mobile Applications' Characteristics: This part of the questionnaire has B2C mobile applications' characteristics in three sections which are presentation, navigation and purchasing. In each section, a six point scale (1= Not Important, 2= Low Level Important, 3=Medium Level Important, 4= High Level Important, 5= Critical Level Important, 6=No Idea) was used. The first and second sections on presentation and navigation respectively have 6 items. The third section on purchasing has 10 items.

Importance Degree of B2C Mobile Quality Factors: This part of the questionnaire has B2C mobile quality factors which have 8 items. In this part, a six point scale (1= Not Important, 2= Low Level Important, 3=Medium Level Important, 4= High Level Important, 5= Critical Level Important, 6=No Idea) was used.

Importance Degree of B2C Mobile Quality Sub-Factors: The final part of the questionnaire consists of B2C mobile quality sub-factors with 30 items. Same as the second and third parts of the study, in this part, a six point scale (1= Not Important, 2= Low Level Important, 3=Medium Level Important, 4= High Level Important, 5= Critical Level Important, 6=No Idea) was used.

The survey used in this study is given in Appendix A.

3.4.2 Interview

Interviews which seek to describe the meanings of the central themes in the life world of the subjects were used to deep understanding of participants' opinion. Kvale (1996) stated interviews are useful to get the story behind a participant's experiences. After the collection of the quantitative data by online survey, interviews were conducted with 3 mobile application developers, 2 software developers, 3 IT experts, and 2 end-users. According to Fraenkel, Wallen & Hyun (2012), interviews have four types which are structured, semi-structured, informal, and retrospective. For this study, semi-structured interviews were used to gather deep information about importance of B2C mobile applications characteristics and B2C quality factors and quality sub-factors from the expert view. The interviews were conducted in a face-to-face manner with 7 participants and video conference with 3 participants.

The semi-structured interview used in this study is given in Appendix B.

3.5 Data Analysis Methods for Research Questions and Research Hypothesis

For the proposed study, data analysis was conducted concurrently, and continued throughout the study (Creswell, 2009). As mixed method was used in the study, both quantitative and qualitative data were obtained in order to answer the research questions. After data is collected it needs to be converted into meaningful and interpretable values in order to start data analysis. Details of the data analysis for each research questions are given in separate sections.

3.5.1 Data Analysis for RQ1 and RQ2

In order to answer the RQ1 and RQ2 which are about the importance degree of B2C mobile applications' characteristics and quality factors, both quantitative and qualitative data were used. Quantitative data which was gathered from online survey was analyzed using statistical methods. In order to discover and interpret the results that were collected from the participants, frequencies were analyzed. Using statistical analysis software, SPSS 20.0, quantitative data was prepared. As it was mandatory for participants to answer the survey questions, there was no missing data in the preparation phase. After all the steps were performed, the descriptive data was analyzed and the results were interpreted.

As mentioned before, to validate quantitative research results for RQ1 and RQ2, qualitative data was used by conducting semi-structured interview. Maxwell (1996) stated that qualitative data analysis is an ongoing activity which starts with the research and lasts until research is completed. There are four basic techniques of qualitative data analysis which are coding, analytical memos, displays, and contextual and narrative analysis (Kaplan & Maxwell, 2005). In this study, coding technique was used in order to analyze the qualitative data gathered from the participants.

With the permission of the participants, interviews were recorded and later transcribed into written form. After that, transcribed data were categorized and placed into a table with respect to research questions. In the fourth step themes and sub-themes were determined. Later, the qualitative data was coded according to themes and sub-themes. Coding is the most frequently used qualitative data analysis technique (Fraenkel, Wallen, & Hyun, 2012). It is the analytic process to form theory via conceptualized and integrated data (Strauss & Corbin, 1998). As the result of this coding process, themes which show the key characteristics and quality factors of B2C mobile applications were generated.

3.5.2 Data Analysis for RQ3

In order to find out whether there were differences about the importance of B2C mobile application characteristics or quality factors based on participants' occupation, one-way Anova was used to test RQ4 with SPSS 20.0. To conduct variance analyses, the homogeneity of the variances for each characteristics and factors were checked. The variance results of each quality characteristics or factors are represented in Appendix C, Appendix D, and Appendix E.

3.5.3 Data Analysis for RQ4 and RQ5

To answer RQ4 and RQ5 which are looking for the relationship of identified characteristics and quality factors in RQ1 and RQ2, factor analysis was used to analyze the survey items that were grouped in a meaningful way by using SPSS 20.0 tool. Moreover, to examine the conceptual models of this study, Structural Equation Modelling (SEM) was used by using Smart PLS software. Structural equation modelling is a multivariate statistical approach that provides researchers to examine both the measurement and the structural components of a model by testing relationships (Geffen, Straub, & Boudreau, 2000). Detailed information about the development of the structural model is given in the next part.

Structural Model Development

Defining the problem statement and justification, two models which are B2C Characteristics and B2C Quality Factors were developed to decrease the effect of the problem.

In order to construct the models, the following steps were followed;

- Looking into existing studies and models;
- Defining the problems of existing studies and models;
- Seek for the characteristics of B2C mobile applications;
- Choosing Garofalaki, Stefani, Stefanis and Xenos' study as a baseline, and revising their constructs' items;
- Seek for the quality of B2C mobile applications;
- Choosing ISO 25010 quality model as a baseline.

As mentioned before, the survey used in this study which is given in Appendix A has 2 main parts corresponding to B2C mobile application characteristics and B2C mobile application quality factors based on ISO25010 quality model.

Development of B2C Characteristics Model

As for the B2C mobile application characteristics, questionnaire items were categorized as follows: (1) Presentation (PRE), (2) Navigation (NAV), and (3) Purchasing (PUR) by revising the Garofalaki, Stefani, Stefanis and Xenos' study (2007).

The structural model for B2C characteristics and relationships of the constructs that were examined by research hypothesis are shown in Figure 3.5.

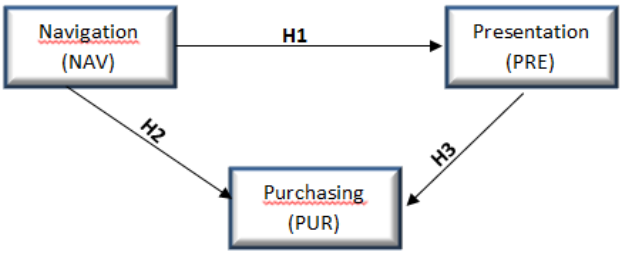

Figure 3.5 Theoretical Structural Model for B2C Mobile Application Characteristics

The items of structural model for B2C mobile applications characteristics are displayed in Table 3.2. All items were gathered from Garofalaki, Stefani, Stefanis and Xenos' study except PRE6, PUR9 and PUR10 which were taken into consideration from literature results.

Table 3.6 Items of Structural Model for B2C Mobile Application Characteristics

Constructs	Abbreviations	Items
Presentation	PRE1	Product's description
	PRE2	Use of text
	PRE3	Use of colors
	PRE4	Use of graphics
	PRE5	Clarity
	PRE6	Appropriateness of presentation
Navigation	NAV1	Navigation Mechanism
	NAV2	Access Keys
	NAV3	Use of Links
	NAV4	Help
	NAV5	Undo functions
	NAV6	User oriented hierarchy
Purchasing	PUR1	Shopping cart- Metaphor
	PUR2	Security mechanism
	PUR3	Pricing mechanism
	PUR4	Alternative payment methods
	PUR5	Authentication
	PUR6	Personalization
	PUR7	Error recovery
	PUR8	Errors tolerance
	PUR9	Operation response time
	PUR10	Accuracy of the operations

3.5.4 Development of B2C Quality Model

For the B2C mobile application quality factors, questionnaire items were categorized as follows: (1) Functional Suitability (FS), (2) Performance Efficiency (PE), (3) Security (S), (4) Usability (U), (5) Reliability (R), (6) Maintainability (M), (7) Compatibility, and (8) Portability (P) by using ISO 25010 quality model items. The structural model for B2C quality factors and relationships of the constructs according to research hypotheses are shown in Figure 3.6.

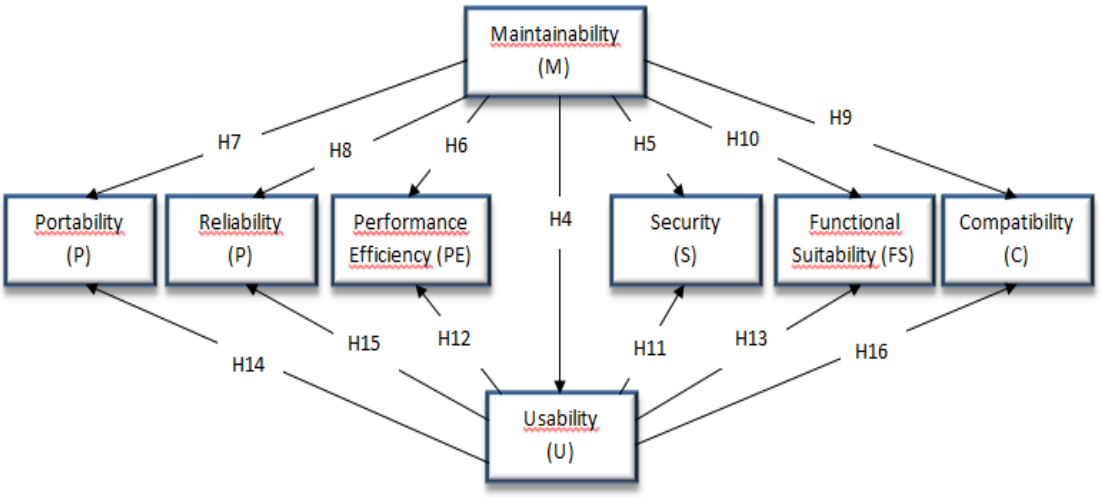

Figure 3.6 Theoretical Structural Model for B2C Mobile Application Factors

The items of structural model for B2C mobile applications quality factors are displayed in Table 3.3. All items were gathered from ISO 25010 quality model.

Table 3.7 Items of Structural Model for B2C mobile application quality factors

Constructs	Abbreviations	Items
Functional Suitability	FS1	Functional Appropriateness
	FS2	Functional Correctness
	FS3	Functional Completeness
Reliability	R1	Maturity
	R2	Availability
	R3	Fault Tolerance
	R4	Recoverability
Performance Efficiency	PE1	Timebehaviour
	PE2	Resource Utilization
	PE3	Capacity
Usability	U1	Appropriateness Recognisability
	U2	Learnability
	U3	Operability
	U4	User Error Protection
	U5	User Interface Aesthetics
	U6	Accessibility
Security	S1	Confidentiality
	S2	Integrity
	S3	Accountability
	S4	Authenticity
Compatibility	C1	Co-existence
	C2	Interoperability
Maintainability	M1	Modularity
	M2	Reusability
	M3	Analyzability
	M4	Modifiability
	M5	Testability
Portability	P1	Adaptability
	P2	Replaceability
	P3	Installability

3.6 Reliability and Validity Issues

Creswell (2012) stated that reviewing the literature should be conducted where there is already an instrument available to measure the variables. Therefore, in order to increase the reliability and validity of the questionnaire and interview instruments, the literature was reviewed to determine whether there are same or similar instruments in the literature. As for the questionnaire review, two questionnaires were found (Garofalakis, Stefani, Stefanis & Xenos, 2007; Behkamal, Kahani & Akbari, 2009). Based on Garofalakis, Stefani, Stefanis & Xenos' study, mobile commerce quality characteristics were listed in three dimensions which are presentation, purchasing and navigation. The questionnaire was extended and used in the second part of the online survey by adding three more items which are

appropriateness of presentation, operation response time and accuracy of the operations. Moreover, Behkamal, Kahani & Akbari's study was adapted in order to measure the importance degree of quality factors and sub-factors of the business-to-customer mobile commerce application. As their study items include ISO 9126 quality factors which are not valid after the publishing of ISO 25010 quality model, items were customized and extended according to ISO 25010 quality factors. Extended and customized items were used in the third and fourth part of the questionnaire.

When the online survey instrument was prepared, a pilot study was conducted to ensure the content validity of the questionnaire. At the first stage, software engineering professionals' opinions were asked to determine whether items were understandable or not. Later, two experts' opinions were gathered while shaping the revised online survey instrument. In the third stage, a pilot study was conducted with six participants. In order to finalize the survey items in terms of validation and grammar, the final version of the online survey form which is shown in Appendix A was developed. As the first section of the instrument obtained nominal data, the other three parts which were adopted and extended from the study, in the instrument were examined in terms of reliability. The Cronbach alpha coefficient was calculated as $\alpha = 0{,}942$ which shows high reliability. The adopted and extended sections of the questionnaire instrument are shown in Table 3.4.

Table 3.8 Distribution of Online Survey Sections

Instrument Section	Adopted from	∑ Item No	Extended or Revised Item No	Cronbach Alpha
Characteristics of Mobile Commerce Application	Garofalakis, Stefani, Stefanis & Xenos, 2007	22	3	0,942
Mobile Commerce Quality Factors	Behkamal, Kahani & Akbari, 2009	8	3	
Mobile Commerce Quality Sub-Factors	Behkamal, Kahani, & Akbari, 2009	30	17	

As for the qualitative data reliability, interview questions in the literature were reviewed just like for quantitative data reliability. From the literature, Alanezi, Mahmood, & Basri's study, which defines e-government service quality in Saudi Arabia, interview questions were adapted and revised to address research questions

of the study. There were eleven questions in their study. To address research questions of this study, six of the questions were taken from their study and revised according to our research questions. Moreover, the online survey questionnaire was taken as a guideline to prepare the interview instrument. After that, a draft version of the interview was designed. Then, two experts' opinions were gathered in order to enhance the instrument. According to these opinions, the interview guideline was revised and finalized as shown in Appendix B.

The finalized interview consisted of 10 main structured questions. 3 main questions were designed to address the important characteristics of B2C mobile applications, and the rest of the questions addressed the quality factors and sub-factors of the B2C mobile applications. The interview was applied to 10 participants who were mobile developers, software developers, IT experts and end-users. The interviews lasted approximately 20 minutes.

The instrument type and addressed research questions and research hypotheses are summarized in Table 3.5 and Table 3.6.

Considering the reliability of RQ3, sample size might be limited for the ANOVA test as the number of information technology experts and end-users are below 30. A popular rule of the T-test answer is "n=30" (Rhiel and Chaffin, 1996). As for the reliability of RQ4 and RQ5, several studies discuss sample size of SEM in terms of reliability of the results. It is still debatable since most of the authors said that sample size must be higher if structural equation modelling is used. Kline (2005) stated that SEM is a large sample technique that sample size is usually higher than 200. However, use of rules (N > 200) for SEM has been discouraged (Goffin 2007; Iacobucci, 2010). Smaller sample will be enough if the model is not very complex, the variables are reliable, and the effects are strong (Bearden, Sharma & Teel 1982; Bollen,1990). Hair (2003) also said that recommended minimum sample size for SEM is between 100 and 150 to ensure the stable Maximum Likelihood Estimation solution. Under these explanations, the sample size used in this study for SEM analysis can be considered acceptable. Moreover, it can be seen that sample size is acceptable as item reliability, composite reliability, and average of extracted variance were achieved as discussed in results part.

Table 3.9 Research Questions vs. Instruments

Research Questions	Quantitative	Qualitative
1. What are the important characteristics of B2C mobile applications?	(Survey - PART II)	(Interview-PART I)
2. What are the most important quality requirements or factors set for B2C mobile applications?	(Survey - PART III)	(Interview-PART II)
3. What is the difference among Mobile Developers (MD), Software Developers (SD), Information Technology Experts (ITE), and End-Users (EU) based on their perceptions about the B2C mobile application characteristics, quality factors, and sub-factors?	(Survey - PART II,III,IV)	-
4. What is the relationship between the characteristics identified in RQ1?	(Survey - PART II)	-
5. What is the relationship between the factors identified in RQ2?	(Survey - PART III, IV)	-
6. Do existing mobile application quality models meet the need of B2C mobile application quality	-	(Interview-PART II)

Table 3.10 Research Hypotheses vs. Instruments

Research Hypothesis	**Quantitative**
H1. Navigation (NAV) has a positive influence on Presentation (PRE). H2. Navigation (NAV) has a positive influence on Purchasing (PUR). H3. Presentation (PRE) has a positive influence on Purchasing (PUR).	(Survey - PART II)
H4. Maintainability (M) construct has a positive influence on Usability (U) construct. H5. Maintainability (M) construct has a positive influence on Security (S) construct. H6. Maintainability (M) construct has a positive influence on Performance Efficiency (PE) construct. H7. Maintainability (M) construct has a positive influence on Portability (P) construct. H8. Maintainability (M) construct has a positive influence on Reliability (R) construct. H9. Maintainability (M) construct has a positive influence on Compatibility (C) construct. H10. Maintainability (M) construct has a positive influence on Functional Suitability (FS) construct. H11. Usability (U) construct has a positive influence on Security (S) construct. H12. Usability (U) construct has a positive influence on Performance Efficiency (PE) construct. H13. Usability (U) construct has a positive influence on Functional Suitability (FS) construct. H14. Usability (U) construct has a positive influence on Portability (P) construct. H15. Usability (U) construct has a positive influence on Reliability (R) construct. H16. Usability (U) construct has a positive influence on Compatibility (C) construct.	(Survey - PART IV)

3.7 Assumptions

For this study, the following assumptions are made:

- The participants will respond accurately to data collection instruments which are online survey and semi-structured interview,
- The data will be accurately recorded and analyzed,

- The results of the collected data is reliable and the indicators of the constructs are valid,
- The purposes, processes, and elements of the framework studied have a degree of applicability for business to customer mobile applications,
- The study which includes data gathering, and findings and conclusion represent "good research".

3.8 Limitations

For this study, the following limitations are listed:

- Validity is limited by the honesty of the subjects' responses to the data collection instruments which are online survey and semi-structured interview,
- Validity is limited by the reliability of the data collection instruments,
- Semi-structured interview is limited by subjects who agree to participate in the interview voluntarily,
- As the participants were drawn by purposive sampling in which participants were selected on the basis of researcher's prior information about participants, instead of random sampling, the sample group could be heterogeneous which is generally not considered appropriate for academic research. Moreover, reliability of purposive sampling is based on the researcher's judgment about the participants may be in error (Fraenkel, Wallen & Hyun, 2012).

3.9 Delimitations

The study was bordered to perform a questionnaire with 34 mobile application developers, 34 software developers, 24 IT experts, and 23 end users to get the users' perspective. Moreover, qualitative data instrument, semi-structured interview, was bordered with 3 mobile application developers, 2 software developers, 3 IT experts, and 2 end-users. The study focused on important characteristics of business to customer mobile applications that increase the quality of the applications. Moreover, it examines both the quality factors and the sub-factors of the business to customer mobile applications not only from developers' view but also from end users' view.

CHAPTER 4

RESULTS

This chapter represents the findings that were obtained from the survey and from the interviews. Under each subtitle, findings related to individual research questions the research questions are presented in detail.

For this study, quantitative and qualitative findings are analyzed separately and then merged to answer the research questions. Quantitative data gathered from the online survey has been subjected to statistical analysis to describe and interpret the results. The interviews were conducted to obtain deeper information about the answers of the research questions, and fill out the missing parts where quantitative data explains insufficiently.

This chapter presents results under the following headings:

- B2C Mobile Application Characteristics;
- B2C Mobile Application Quality Factors;
- Differences among Mobile Developer (MD), Software Developer (SD), IT Expert (ITE) and End-User (EU) evaluations;
- Relationships among B2C Mobile Characteristics;
- Relationships among B2C Mobile Quality Factors;
- Need for a B2C Mobile Application Quality Model.

4.1 B2C Mobile Application Characteristics (RQ1)

Participants were asked to associate importance degrees with B2C mobile application characteristics in three dimensions which are presentation, navigation and purchasing.

As seen from Table 4.1, clarity (45.2%) has the critical degree importance level for the presentation dimension. Product's description and appropriateness of presentation are the ones which have critical degree importance. However, participants reported

that use of text is not critically important as it has low degree of importance (27.0%) and middle degree importance (53.9%).

In terms of the characteristics of presentation dimension, clarity, appropriateness of presentation, product's description, and use of graphics have been associated with values above 4.00, whereas the use of colors and use of text have been given values below 4.00.

Table 4.1 Participants' Responses to Presentation Dimension in Questionnaire Items

Items *	**(1) %**	**(2) %**	**(3) %**	**(4) %**	**(5) %**	**(6) %**	**Responses Mean**
Product's description	0,9	0,9	13,0	43,5	41,7	0,0	4,24
Use of Text	5,2	27,0	53,9	13,0	0,9	0,0	3,77
Use of Colors	0,0	1,7	30,4	39,1	27,8	0,9	3,96
Use of Graphics	0,0	2,6	20,0	40,9	35,7	0,9	4,12
Clarity	0,0	0,0	6,1	47,0	45,2	1,7	4,43
Appropriateness of Presentation	0,0	0,9	13,9	41,7	40,9	2,6	4,30

* "(1) Not Important", "(2) Low Degree Important", "(3) Middle Degree Important", "(4) High Degree Important", "(5) Critical Degree Important", "(6) No Idea"

To validate the quantitative results for RQ1, the below questions were asked to participants in semi-structured interview;

Question 1: What are the most important characteristics of B2C mobile applications?

Question 2: Which features of B2C mobile applications constitute positive thoughts for you?

Question 3: Which features of B2C mobile applications constitute negative thoughts for you? What is your suggestion about development in order to remove negative thoughts?

As these questions overlapped with the RQ2, their details were given in B2C Mobile Application Quality Factors part. Some of the participants' opinions in the interview for the RQ1 are given below for each dimension separately. The original responses in Turkish are provided in Appendix F.

Two interviewees stated the importance of presentation dimension as:

"In the sense of user experience, use of graphics must be properly selected, it must have a clear interface, and must not be complex" (Interviewee 9, SD / Opinion1.1)

"As it is a commercial activity, when we offer something to a user, application must be attractive as for the visuality or the design just like web-sites" (Interviewee 3, MD / Opinion1.2)

As for the Navigation dimension, participants' responses are shown in Table 4.2. It can be seen from the table that navigation mechanism (55.7%) is critically important. On the other hand, help has not a critical importance as participants chose it has medium level importance (42.6%) and low level importance (22.6%). In terms of the characteristics of navigation dimension, navigation mechanism, user oriented hierarchy, and access keys are above 4.00 respectively, whereas use of links, undo functions, and help are below 4.00.

Table 4.2 Participants' Responses to Navigation Dimension in Questionnaire Items

Items *	**(1) %**	**(2) %**	**(3) %**	**(4) %**	**(5) %**	**(6) %**	**Responses Mean**
Navigation	0,0	1,7	7,0	34,8	55,7	0,9	4,47
Access keys	0,9	2,6	12,2	42,6	40,0	1,7	4,23
Use of Links	0,0	6,1	27,0	42,6	21,7	2,6	3,88
Help	4,3	22,6	42,6	15,7	14,8	0,0	3,14
Undo functions	0,0	12,2	27,8	27,0	32,2	0,9	3,82
User oriented	0,0	1,7	12,2	40,9	45,2	0,0	4,30

* "(1) Not Important", "(2) Low Degree Important", "(3) Middle Degree Important", "(4) High Degree Important", "(5) Critical Degree Important", "(6) No Idea"

Two of the interview participants mentioned the importance of navigation mechanism by stating that:

"Easy of navigation and not having to jump from page to page are very important. Navigation should be very well defined, as the mobile environment is limited. Much effort must be spent on navigation since a mobile application is much less powerful than a web site." (Interviewee 9, SD / Opinion1.3)

"Navigation is very important. We see some applications in which when we click something, it does something else. We cannot find the buttons that we are looking for like main page, settings" (Interviewee 4, ITE / Opinion1.4)

As seen from Table 4.3, security mechanism (77.4%) is critically important for the purchasing mechanism. Moreover, accuracy of the operations (68.7%) and authentication (50.4%) are the others that have critical importance level respectively. However, personalization is the medium level importance (36.5%) and low level importance (15.7%).

In terms of the characteristics of purchasing dimension, security mechanism, accuracy of the operations, authentication, operation response time, error recovery, and pricing mechanism are associated with values above 4.00, whereas error tolerance, shopping cart, alternative payment methods, and personalization are below 4.00.

Table 4.3 Participants' Responses to Purchasing Dimension in Questionnaire Items

Items *	**(1) %**	**(2) %**	**(3) %**	**(4) %**	**(5) %**	**(6) %**	**Responses Mean**
Shopping cart –Metaphor	0,9	6,1	26,1	34,8	32,2	0,0	3,91
Security mechanism	1,7	0,0	2,6	18,3	77,4	0,0	4,70
Pricing Mechanism	0,9	2,6	13,0	48,7	34,8	0,0	4,13
Alternative payment	0,9	7,8	24,3	37,4	29,6	0,0	3,87
Authentication	0,9	2,6	7,8	38,3	50,4	0,0	4,35
Personalization	2,6	15,7	36,5	27,0	18,3	0,0	3,43
Error recovery	1,7	0,0	18,3	40,0	40,0	0,0	4,15
Errors tolerance	2,6	0,9	23,5	37,4	35,7	0,0	3,99
Operation Response time	0,0	0,9	16,5	40,9	41,7	0,0	4,23
Accuracy of the	0,0	0,0	4,3	27,0	68,7	0,0	4,64

* "(1) Not Important", "(2) Low Degree Important", "(3) Middle Degree Important", "(4) High Degree Important", "(5) Critical Degree Important", "(6) No Idea"

Most of the interview participants mentioned the importance of security mechanism if there is money transaction with credit card information. Some of the interviewers' opinions are given below:

"Security is a more important subject; it must convince you in some way that it is secured. Payment systems and the product that you checked out till it is reserved for you have to be considered very carefully" (Interviewee 9, SD / Opinion1.5)

"In a mobile commerce application, purchasing, shopping, banks, and credit cards enter into business as it includes part of the trade. Therefore, in order to make users more comfortable, we need to make users feel good in terms of security. We should be certain that we do not have any security gaps. Especially in Turkey, users consider the security more before giving credit cards information in the process of buying product." (Interviewee 3, MD / Opinion1.6)

"Privacy is important for me. Security comes to my mind at first. How my personal information is used by applications make me feel anxious. When installing an application, I read the description first and consider what kind of personal information they get" (Interviewee 6, ITE / Opinion1.7)

"The most important feature is the security as giving the credit card information. Secondly, how well the product visuals are presented is important" (Interview 8, EU / Opinion1.8)

4.2 B2C Mobile Application Quality Factors (RQ2)

Participants were asked to associate importance degree of B2C mobile application quality factors in a questionnaire. As can be seen from the Table 4.4, security has the highest critical importance with 73.9 %. This result confirms the security mechanism (77.4%) which was discussed in B2C mobile characteristics for purchasing dimension. Reliability (67.0 %) and usability (51.3 %) are also critically important.

Functional suitability (53.0%) and performance efficiency (50.4%) are the ones which have high level of importance. It can be seen from the table that portability has the least critical importance level with 17.4 %.

In terms of the quality factors, all the quality factors are above 4.00 except portability.

Table 4. 4 Participants' Responses to B2C Mobile App. Quality Factors in Questionnaire Items

Items *	**(1) %**	**(2) %**	**(3) %**	**(4) %**	**(5) %**	**(6) %**	**Responses Mean**
Functional Suitability:	0,9	0,0	7,0	53,0	39,1	0,0	4,30
Reliability:	0,0	0,0	2,6	30,4	67,0	0,0	4,64
Performance	0,0	0,0	9,6	50,4	40,0	0,0	4,30
Usability:	0,0	0,0	7,0	41,7	51,3	0,0	4,44
Security:	0,0	0,0	7,8	18,3	73,9	0,0	4,66
Compatibility:	0,0	4,3	17,4	43,5	33,0	1,7	4,10
Portability:	0,0	10,4	25,2	46,1	17,4	0,9	3,73
Maintainability:	0,9	2,6	10,4	43,5	42,6	0,0	4,24

* "(1) Not Important", "(2) Low Degree Important", "(3) Middle Degree Important", "(4) High Degree Important", "(5) Critical Degree Important", "(6) No Idea"

To validate the quantitative results for the RQ2, the below questions which are 1, 2, 3, 5, 6, 9 and 10 in the semi-structured interview were conducted;

Question 1: What are the most important characteristics of B2C mobile applications?

Question 2: Which features of B2C mobile applications constitute positive thoughts for you?

Question 5: What are the B2C mobile applications' factors that increase use depending on your experience?

The aim was to identify features or factors that lead to compose positive opinions on users' minds through questions 1, 2 and 5. Therefore, results are combined.

The results of the interview coding are shown in Table 4.5. It can be seen from the table that all the participants mentioned the importance of usability issue by especially navigation subject. Moreover, most of the participants stated the importance of security, presentation, reliability issues. Furthermore, one of the interviewee mentioned the importance of localization feature for himself by stating that it would help to make effective filtering.

Table 4.5 Participants' Answers to the Interview Question 1, 2, and 5

Participants	Answers
10 of the participants	Usability which includes navigation, simplicity, learnability and ease of use.
9 of the participants	Security shows banking operations are safely done. Presentation which includes use of graphics and text, clarity of the interface, attractive design. Reliability which shows all banking transactions are done accurately.
4 of the participants	Functional Suitability shows the application reserve its aim correctly. Performance Efficiency displays the users can do what they want quickly.
1 of the participant	Localization which provides to more effective filtering mechanism.

Some of the interviewer opinions are given below:

"If there is money movement in the application, reliability is important. Transaction of money is done in a reliable way, and my credit card information will not get into someone's hands are important factors. At this point security comes first, and then reliability comes. In addition to these, ease of use, navigation system, and the design are important." (Interviewee 10, SD / Opinion2.1)

"Security comes first. After the security, usability of the application comes in the second place. As the mobile phone's screen is not very big, it is important to easily use with fingers or not, and I can use easily in terms of navigation is important." (Interviewee 6, ITE / Opinion2.2)

"Functionality, security, and usability should be good. If it is commercial application, some information needs to be entered. The entrances of the credit card details need to be easy." (Interviewee 7, EU / Opinion2.3)

"At first comes speed, and stability. It must be user friendly and users must not confront any difficulties. For example, the button has been moved to the right, or is at an invisible point. Add to cart, and delete are somewhere else." (Interviewee 5, ITE / Opinion2.4)

To identify features or factors that lead to compose negative opinions on users' minds so it would help to give more attention such features or factors on development process through questions 3 and 6. Therefore, results are combined.

Question 3: Which features of B2C mobile applications constitute negative thoughts for you? What is your suggestion about development in order to remove negative thoughts?

Question 6: What are the B2C mobile applications' factors that decrease use depending on your experience? What is your suggestion about development in order to remove factors that decrease the use?

According to results of the interview coding, if the positive features or factors have not been established, it will influence users negatively. As an example, if the navigation mechanism is not good enough, then it brings a negative thought for the user. Therefore, all the positive features or factors should be provided. In addition to this, device compatibility and internet connection problems were mentioned by most of the participants. Especially if the 3G speed is not provided, a user can confront internet connection problems when carrying out some operation.

In order to decrease such problems, one of the interviewees suggested that:

"Users mention that application is not working or gives error message if 3G service is not good enough in some places. It needs to be taken into consideration during development. Some of the functions of the application need to run in an asynchronous manner. Also, user can be informed that in order to perform some functions internet speed should be higher" (Interviewee 3, MD / Opinion2.5)

Moreover, as a problem of feeling insecure, mobile developers, software developers and IT experts mentioned that the security certifications would be helpful for users to feel more secure. Also, one of the IT experts stated that it would be good to be informed about the quality control mechanisms results in terms of security.

To understand the most important quality factors by ordering, question 9 was asked.

Question 9: What are the most important quality factors for B2C mobile application considering the ISO 25010 quality factors?

Table 4.6 Participants' Answers to the Interview Question 9

Participants	**Answers**
8 of the Participants	Usability
7 of the Participants	Security
4 of the Participants	Functional Suitability and Reliability

It is apparent from Table 4.6 that most of the participants think that usability and security are the most important quality factors for B2C mobile applications considering limited cell phone's screen and feeling insecure in comparison to desktop computer. 4 of the participants also stated that functional suitability and reliability are important quality factors for B2C mobile applications. Moreover, it can be seen that the result of the question 9 is compatible with the result of combined questions which are 1, 2 and 5.

One of the interviewees mentioned the importance of usability by stating that:

"As screen is small which is the biggest problem in the mobile environment, ease of data entry must be provided. People who have chubby fingers like me have difficulty entering the information. Ease of information entry eases application usage. As an example, @ sign is in the first screen on virtual keyboard in apple. It will make pretty easier when I enter my email address information" (Interviewee 7, EU / Opinion2.6)

Another interviewee mentioned the importance of security by stating that:

"In the mobile environment, one feels a little more insecure and lacks control. We do not know what the application takes from us like discharging phonebook, reaching pictures etc." (Interviewee 6, ITE / Opinion2.7)

To understand the least important quality factor by interviewee's order, question 10 was conducted.

Question 10: What are the least important quality factors for B2C mobile application considering the ISO 25010 quality factors?

Table 4.7 Participants' Answers to the Interview Question 10

Participants	**Answers**
6 of the Participants	Portability
4 of the Participants	Compatibility
2 of the Participants	Performance Efficiency and Maintainability

As can be seen from Table 4.7, 6 of the participants consider that portability is the least important factor on mobile commerce application mentioning that they do not need such thing.

One of the interviewees who is mobile developer stated that:

"Portability is not so important for users; different technologies and platforms are used" (Interviewee 3, MD / Opinion2.8).

One of the interviewees verified the mobile developer opinion by stating that:

"Just because I use an Apple application, portability is not important for me" (Interviewee 7, EU / Opinion2.9)

Moreover, 4 of the participants stated that compatibility is not such an important factor since it depends on the software requirements of the application.

B2C Mobile Application Quality Sub-Factors

Participants were asked to associate importance degree of mobile commerce quality sub-factors in the questionnaire.

As can be seen from the Table 4.8, confidentiality and recoverability have the highest critical importance with 53.0 percent. It confirms the main quality factors result as confidentiality belongs to security and recoverability belongs to reliability. As for the least critical importance, adaptability (10.4%), replaceability (7.8%) and installability (6.1%) can be seen which also confirms the portability quality factor result.

In terms of the quality sub-factors, functional correctness, recoverability, confidentiality, availability, functional appropriateness, fault tolerance, maturity, integrity, authenticity, time-behavior, user error protection, user interface aesthetics, functional completeness, accountability, modifiability, testability, and learnability are the ones above 4.00, whereas accessibility, analyzability, operability, modularity, capacity, resource utilization, appropriateness recognisability, installability, reusability, adaptability, replaceability, and co-existence are the ones below 4.00.

Table 4.8 Participants' Responses to B2C Mobile App. Quality Sub Factors in Questionnaire Items

Items *	**(1) %**	**(2) %**	**(3) %**	**(4) %**	**(5) %**	**(6) %**	**Responses Mean**
Functional Appropriateness	0,9	0,0	9,6	54,8	33,0	1,7	4,24
Functional Correctness	0,0	0,0	6,1	48,7	43,5	1,7	4,41
Functional Completeness	0,0	0,0	14,8	58,3	26,1	0,9	4,13
Maturity:	0,0	1,7	12,2	47,8	37,4	0,9	4,23
Availability:	0,0	0,0	11,3	42,6	44,3	1,7	4,37
Fault tolerance:	0,0	0,9	15,7	42,6	40,0	0,9	4,24
Recoverability:	0,0	1,7	11,3	33,0	53,0	0,9	4,40
Timebehaviour:	0,0	1,7	11,3	53,9	33,0	0,0	4,18
Resource Utilization	0,0	5,2	20,9	54,8	18,3	0,9	3,89
Capacity	0,0	5,2	22,6	47,8	21,7	2,6	3,94
Appropriateness	0,0	5,2	26,1	47,8	17,4	3,5	3,88
Learnability	0,9	2,6	24,3	40,0	32,2	0,0	4,00
Operability	0,0	2,6	25,2	46,1	24,3	1,7	3,97
User Error Protection	0,0	2,6	15,7	43,5	38,3	0,0	4,17
User Interface Aesthetics	0,0	0,9	13,0	53,9	32,2	0,0	4,17
Accessibility	0,0	4,3	25,2	40,0	28,7	1,7	3,98
Confidentiality	0,0	1,7	10,4	34,8	53,0	0,0	4,39
Integrity	0,0	0,0	13,0	53,9	32,2	0,9	4,20
Accountability	0,0	6,1	15,7	40,0	38,3	0,0	4,10
Authenticity	0,0	6,1	12,2	39,1	40,9	1,7	4,20
Co-existence	0,9	13,0	25,2	43,5	14,8	2,6	3,66
Interoperability	0,0	8,7	18,3	51,3	19,1	2,6	3,89
Modularity	0,9	4,3	23,5	46,1	20,9	4,3	3,95
Reusability	0,9	3,5	27,8	49,6	17,4	0,9	3,82
Analyzability	0,0	2,6	24,3	47,8	24,3	0,9	3,97
Modifiability	0,0	4,3	17,4	47,8	28,7	1,7	4,06
Testability	0,9	3,5	18,3	47,8	28,7	0,9	4,03
Adaptability	1,7	10,4	21,7	44,3	20,9	0,9	3,75
Replaceability	3,5	7,8	27,8	37,4	20,9	2,6	3,72
Installability	1,7	6,1	26,1	39,1	25,2	1,7	3,85

***** "(1) Not Important", "(2) Low Degree Important", "(3) Middle Degree Important", "(4) High Degree Important", "(5) Critical Degree Important", "(6) No Idea"

One of the interviewees who is an IT Expert mentioned the availability of the application is important by stating that:

"Considering the shopping web sites in internet, mobile application should be available 7/24, and able to operate continuously. I do not want to lose my operation in a certain period. In some applications, I encounter traffic congestion, and I cannot perform the operation that I want." (Interviewee 6, ITE / Opinion2.10)

One of the interviewees who is a software developer mentioned the learnability of the application is important by stating that:

"Without any support and the help document, I must be able to use the application." (Interviewee 10, SD / Opinion2.11)

One of the interviewees who is an IT Expert mentioned the functional appropriateness and time behavior of the application are important by stating that:

"I think functionality and serving the purpose of the application are important. For instance, let me mention a bank application. If I want to carry out an EFT, I must be able to quickly do that" (Interviewee 4, ITE / Opinion2.12)

4.3 Differences among MD, SD, ITE, and EU (RQ3)

As mentioned in methodology part, in order to find out whether there are differences about the importance of B2C mobile application characteristics or quality factors based on participants' occupation, one-way Anova was used to test the research question 4. To conduct variance analyses, the homogeneity of the variances for each characteristics and factors were checked. The variance results of each quality characteristics or factors are represented in Appendix C, Appendix D, and Appendix E.

From the ANOVA results, there are four items which have statistically significant difference at $p < .05$ level for the participants' occupation. Those factors are use of graphics, appropriateness of presentation, functional suitability, and integrity. Next sections explore the results of each item independently.

Variance Analysis of Use of Graphics

As shown in Appendix E, the Levene statistics test of homogeneity of variance yielded a non-significant p value (.108, $p < .05$) which could be interpreted as equal variance assumption was met. After checking homogeneity of variance, one way ANOVA was conducted to examine the importance degree difference on use of graphics characteristic among the participants. The results of the test were presented in Table 4.9 and Table 4.10.

Table 4.9 Descriptive Statistics for Each Group Dependent Variable Use of Graphics for Anova

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
Mobile D.	34	4.471	.6622	.1136	4.2395	4.7016	3.00	5.00
Software D.	34	3.941	1.013	.1738	3.5876	4.2947	2.00	6.00
IT Expert	24	4.000	.7223	.1474	3.6950	4.3050	3.00	5.00
End-User	23	4.000	.7385	.1540	3.6806	4.3194	3.00	5.00
Total	11	4.121	.8287	.0772	3.9686	4.2748	2.00	6.00

Table 4.10 Use of Graphics Variations According to Participants Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between	5.943	3	1.981	3.039	.032
Within Groups	72.353	111	.652		
Total	78.296	114			

As can be seen from Table 4.9 average importance degree of use of graphics were observed for Mobile Developer, Software Developer, IT Expert, End-User as M = 4.47 (SD = 0.66), M = 3.94 (SD = 1.01), M = 4.00 (SD = 0.72), M = 4.00 (SD=0.73) respectively. It can be seen that importance of use of graphics has the highest value from mobile developer while software developer was the last in terms of the importance of use of graphics. In order to examine whether the mean scores different significantly across groups, Table 4.10 which shows the results of ANOVA procedure was examined. According to Table 4.10, there was a statistically significant difference at $p < .05$ level for the importance degree of use of graphics for each group; $F(3,111) = 3.039$, $p = .032$. In order to identify which groups differ from the rest, post hoc test was applied. Results of the post hoc test are shown in Table 4.11.

Table 4.11 LSD Post Hoc Test Results – Dependent Variable: Use of Graphics

(I)Title		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Lower Bound	95% Confidence Upper Boun
Mobile D.	Software D.	.52941*	.19581	.008	.1414	.9174
	IT Expert	.47059*	.21525	.031	.0441	.8971
	End-User	.47059*	.21797	.033	.0387	.9025
Software D.	Mobile D.	-.52941*	.19581	.008	-.9174	-.1414
	IT Expert	-.05882	.21525	.785	-.4853	.3677
	End-User	-.05882	.21797	.788	-.4907	.3731
IT Expert	Mobile D.	-.47059*	.21525	.031	-.8971	-.0441
	Software D.	.05882	.21525	.785	-.3677	.4853
	End-User	0.00000	.23558	1.000	-.4668	.4668
End-User	Mobile D.	-.47059*	.21797	.033	-.9025	-.0387
	Software D.	.05882	.21797	.788	-.3731	.4907
	IT Expert	0.00000	.23558	1.000	-.4668	.4668

*. The mean difference is significant at the 0.05 level.

Looking at the Sig. column in Table 4.11, there are some values which are less than 0.05. These values correspond with the comparison between Mobile Developer and Software Developer (p=0.008), Mobile Developer and IT Expert (p=0.031), and Mobile Developer and End-Users (p=0.033). For this reason, we can conclude that Mobile Developer and Software developer, Mobile Developer and IT Expert, and Mobile Developer and End-Users conditions are significantly different in terms of importance of use of graphics. However, the other condition comparisons are not significantly different from one another. Use of graphic's mean is also shown in Figure 4.1 below based on title condition.

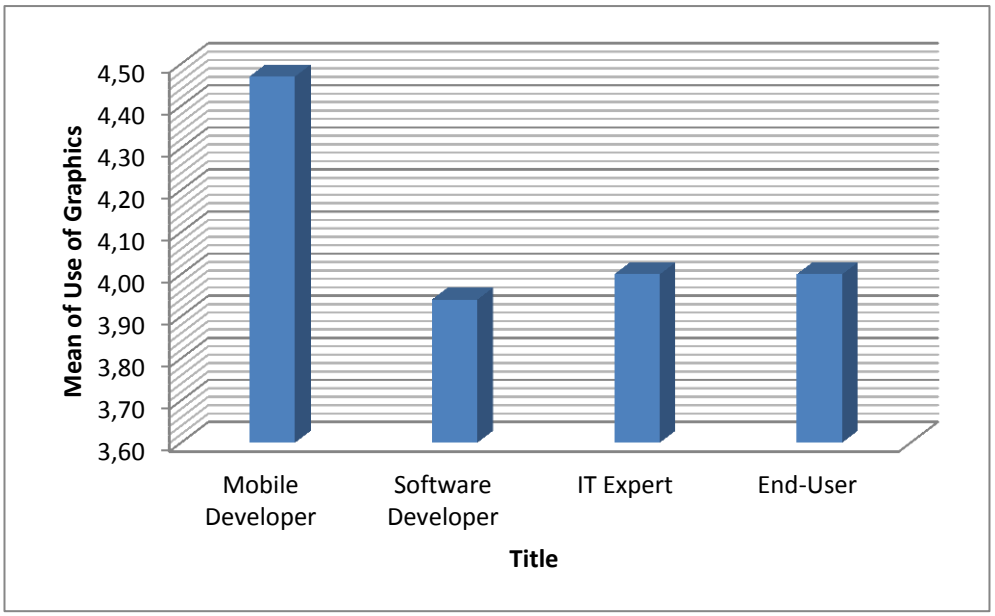

Figure 4.1 Mean of Use of Graphics based on Title condition

Variance Analysis of Appropriateness of Presentation

The Levene statistics test of homogeneity of variance yielded a non-significant p value (.146, $p < .05$) which could be interpreted as equal variance assumption was met. After checking homogeneity of variance, one way ANOVA was conducted to examine the importance degree difference on appropriateness of presentation characteristic among the participants. The results of the test are presented in Table 4.12 and Table 4.13.

Table 4.12 Descriptive Statistics for Each Group Dependent Variable Appropriateness of Presentation for Anova

Groups	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
					Low. Bound	Up. Bound		
Mobile D.	34	4.177	.7165	.1229	3.9265	4.4265	3.00	6.00
Software D.	34	4.617	.6037	.1035	4.4070	4.8283	3.00	6.00
IT Expert	24	4.250	.8968	.1830	3.8713	4.6287	3.00	6.00
End-User	23	4.087	.8481	.1768	3.7202	4.4537	2.00	5.00
Total	115	4.304	.7743	.0722	4.1613	4.4474	2.00	6.00

Table 4.13 Appropriateness of Presentation According to Participants Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.051	3	1.684	2.953	.036
Within Groups	63.297	111	.570		
Total	68.348	114			

As can be seen from Table 4.12 average importance degree of use of graphics were observed for Mobile Developer, Software Developer, IT Expert, End-User as M = 4.17 (SD = 0.71), M = 4.61 (SD = 0.60), M = 4.25 (SD = 0.89), M = 4.08 (SD=0.84) respectively. It can be seen that importance of appropriateness of presentation has the highest value from software developer while others was the last in terms of the importance of appropriateness of presentation. In order to examine whether the mean scores different significantly across groups, Table 4.13 which shows the results of ANOVA procedure was examined. According to Table 4.13, there was a statistically significant difference at $p < .05$ level for the importance degree of appropriateness of presentation for each group; $F(3,111) = 2.953$, $p = .036$.

In order to identify which groups differ from the rest, post hoc test was applied. Results of the post hoc test are shown in Table 4.14.

Table 4.14 LSD Post Hoc Test Results – Dependent Variable: Appropriateness of Presentation

(I)Title		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Mobile D.	Software D.	-.44118*	.18315	.018	-.8041	-.0783
	IT Expert	-.07353	.20133	.716	-.4725	.3254
	End-User	.08951	.20387	.661	-.3145	.4935
Software D.	Mobile D.	.44118*	.18315	.018	.0783	.8041
	IT Expert	.36765	.20133	.071	-.0313	.7666
	End-User	.53069*	.20387	.011	.1267	.9347
IT Expert	Mobile D.	.07353	.20133	.716	-.3254	.4725
	Software D.	-.36765	.20133	.071	-.7666	.0313
	End-User	.16304	.22035	.461	-.2736	.5997
End-User	Mobile D.	-.08951	.20387	.661	-.4935	.3145
	Software D.	-.53069*	.20387	.011	-.9347	-.1267
	IT Expert	-.16304	.22035	.461	-.5997	.2736

*. The mean difference is significant at the 0.05 level.

Looking at the Sig. column in Table 4.14, it can be seen that most of the values are greater than 0.05. However, there are four values less than 0.05. These values correspond with the comparison between the Mobile Developer and Software Developer (p=0.018), and Software Developer and End-User (p=0.011). For this reason, we can conclude that Mobile Developer and Software Developer, and Software Developer and End-User conditions are significantly different in terms of importance of appropriateness of presentation. However, the other condition comparisons are not significantly different from one another. Appropriateness of presentation's mean is also shown in Figure 4.2 below based on title condition.

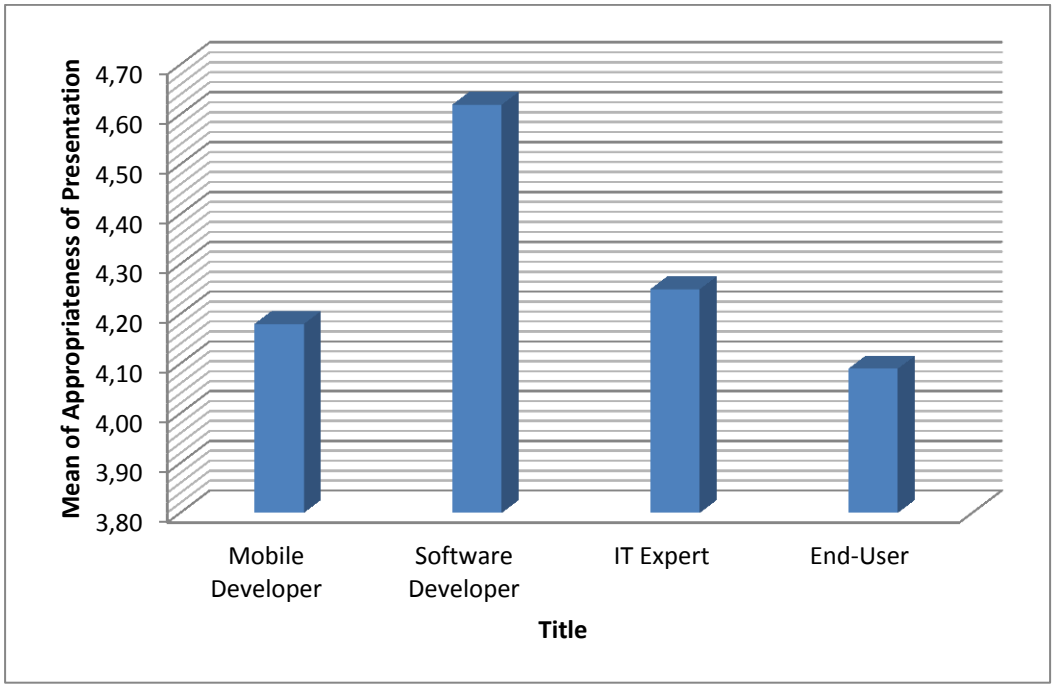

Figure 4.2 - Mean of Appropriateness of Presentation based on Title condition

Variance Analysis of Functional Suitability

The Levene statistics test of homogeneity of variance yielded a non-significant p value (.558, $p < .05$) which could be interpreted as equal variance assumption was met. After checking homogeneity of variance, one way ANOVA was conducted to examine the importance degree difference on functional suitability quality factor among the participants. The results of the test were presented in Table 4.15 and Table 4.16.

Table 4.15 Descriptive Statistics for Each Group Dependent Variable Functional Suitability for Anova

Groups	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
					Low. Bound	Up. Bound		
Mobile D.	34	4.294	.5239	.0898	4.1113	4.4769	3.00	5.00
Software D.	34	4.441	.6125	.1050	4.2274	4.6549	3.00	5.00
IT Expert	24	4.416	.5835	.1191	4.1702	4.6631	3.00	5.00
End-User	23	3.956	.9282	.1935	3.5551	4.3579	1.00	5.00
Total	115	4.295	.6750	.0629	4.1710	4.4204	1.00	5.00

Table 4. 16 Appropriateness of Presentation According to Participants Groups

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.717	3	1.239	2.851	.041
Within Groups	48.231	111	.435		
Total	51.948	114			

As can be seen from Table 4.15 average importance degree of functional suitability were observed for Mobile Developer, Software Developer, IT Expert, End-User as M = 4.29 (SD = 0.52), M = 4.44 (SD = 0.61), M = 4.41 (SD = 0.58), M = 3.95 (SD=0.92) respectively. It can be seen that importance of functional appropriateness has the highest value software developer while End-User was the last in terms of the importance of functional appropriateness. In order to examine whether the mean scores different significantly across groups, Table 4.16 which shows the results of ANOVA procedure was examined. According to Table 4.16, there was a statistically significant difference at $p < .05$ level for the importance degree of functional appropriateness for each group; $F(3,111) = 2.851$, $p = .041$.

In order to identify which groups differ from the rest, post hoc test was applied. Results of the post hoc test are shown in Table 4.17.

Table 4.17 LSD Post Hoc Test Results – Dependent Variable: Functional Suitability

(I)Title		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Mobile D.	Software D.	-.14706	.15987	.360	-.4639	.1697
	IT Expert	-.12255	.17574	.487	-.4708	.2257
	End-User	.33760	.17797	.060	-.0151	.6902
Software D.	Mobile D.	.14706	.15987	.360	-.1697	.4639
	IT Expert	.02451	.17574	.889	-.3237	.3728
	End-User	.48465*	.17797	.008	.1320	.8373
IT Expert	Mobile D.	.12255	.17574	.487	-.2257	.4708
	Software D.	-.02451	.17574	.889	-.3728	.3237
	End-User	.46014*	.19235	.018	.0790	.8413
End-User	Mobile D.	-.33760	.17797	.060	-.6902	.0151
	Software D.	-.48465*	.17797	.008	-.8373	-.1320
	IT Expert	-.46014*	.19235	.018	-.8413	-.0790

*. The mean difference is significant at the 0.05 level.

Looking at the Sig. column in Table 4.17, it can be seen that most of the values are greater than 0.05. However, there are four values less than 0.05. These values correspond with the comparison between the Software Developer and End-User, and IT Expert and End-User. For this reason, we can conclude that the Software Developer and End-User, and IT Expert and End-User conditions are significantly

different in terms of importance of functional suitability. However, the other condition comparisons are not significantly different from one another. Functional suitability mean is also shown in Figure 4.3 below based on title condition.

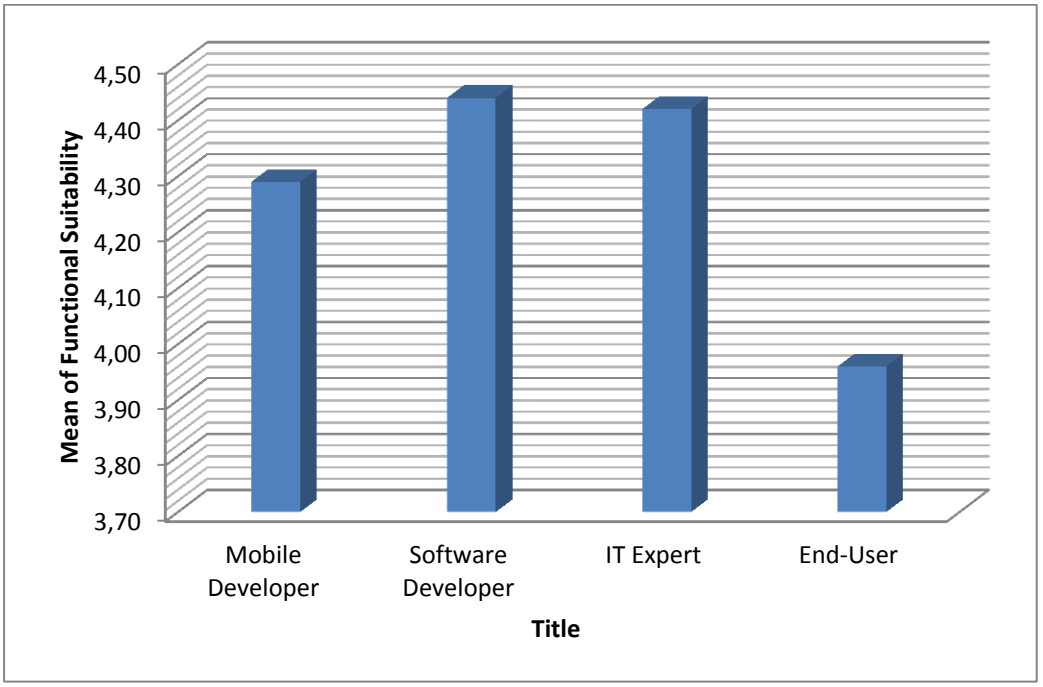

Figure 4.3 Mean of Functional Suitability based on Title condition

Variance Analysis of Integrity

The Levene statistics test of homogeneity of variance yielded a non-significant p value (.159, $p < .05$) which could be interpreted as equal variance assumption was met. After checking homogeneity of variance, one way ANOVA was conducted to examine the importance degree difference on integrity factor among the participants. The results of the test were presented in Table 4.18 and Table 4.19.

Table 4.18 Descriptive Statistics for Each Group Dependent Variable Integrity

Groups	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
					Low. Bound	Up. Bound		
Mobile D.	34	4.058	.7762	.1331	3.7880	4.3297	3.00	6.00
Software D.	34	4.294	.6290	.1078	4.0746	4.5136	3.00	5.00
IT Expert	24	4.541	.5089	.1038	4.3267	4.7566	4.00	5.00
End-User	23	3.956	.5623	.1172	3.7134	4.1997	3.00	5.00
Total	11	4.208	.6688	.0623	4.0851	4.3322	3.00	6.00

Table 4.19 Integrity According to Participants Groups

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between	5.135	3	1.712	4.144	.008
Within	45.856	111	.413		
Total	50.991	114			

As can be seen from Table 4.18 average importance degree of use of graphics were observed for Mobile Developer, Software Developer, IT Expert, End-User as M = 4.05 (SD = 0.77), M = 4.29 (SD = 0.62), M = 4.54 (SD = 0.50), M = 3.95 (SD=0.56) respectively. It can be seen that importance of integrity has the highest value from IT expert while End-User was the last in terms of the importance of appropriateness of presentation. In order to examine whether the mean scores different significantly across groups, Table 4.19 which shows the results of ANOVA procedure was examined. According to Table 4.19, there was a statistically significant difference at $p < .05$ level for the importance degree of integrity for each group; $F(3,111) = 4.144$, $p = .008$.

In order to identify which groups differ from the rest, post hoc test was applied. Results of the post hoc test are shown in Table 4.20.

Table 4.20 LSD Post Hoc Test Results – Dependent Variable: Integrity

					95% Confidence Interval	
(I)Title		Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Mobile D.	Software D.	-.23529	.1558	.134	-.5442	.0736
	IT Expert	-.48284*	.1713	.006	-.8224	-.1433
	End-User	.10230	.1735	.557	-.2416	.4462
Software D.	Mobile D.	.23529	.1558	.134	-.0736	.5442
	IT Expert	-.24755	.1713	.151	-.5871	.0920
	End-User	.33760	.1735	.054	-.0063	.6815
IT Expert	Mobile D.	.48284*	.1713	.006	.1433	.8224
	Software D.	.24755	.1713	.151	-.0920	.5871
	End-User	.58514*	.1875	.002	.2135	.9568
End-User	Mobile D.	-.10230	.1735	.557	-.4462	.2416
	Software D.	-.33760	.1735	.054	-.6815	.0063
	IT Expert	-.58514*	.1875	.002	-.9568	-.2135

*. The mean difference is significant at the 0.05 level.

Looking at the Sig. column in Table 4.20, it can be seen that there are four values that are less than 0.05. These values correspond with the comparison between the Mobile Developer and IT Expert (p=0.006), and IT Expert and End-User (p=0.002).

For this reason, we can conclude that the Mobile Developer and IT Expert, and IT Expert and End-User conditions are significantly different in terms of importance of integrity. However, the other condition comparisons are not significantly different from one another. Integrity's mean is also shown in Figure 4.4 below based on title condition.

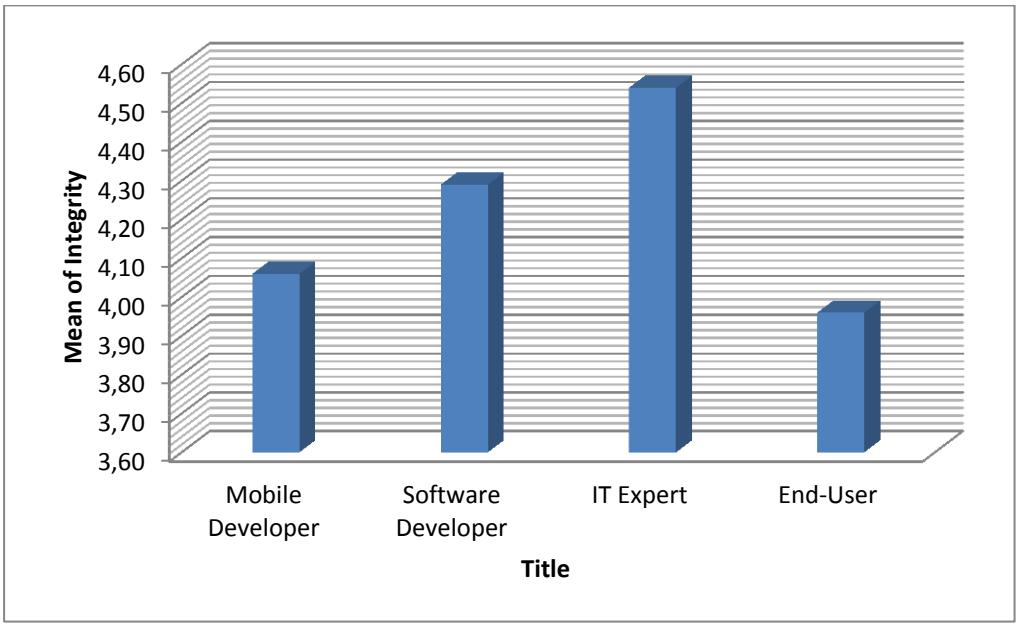

Figure 4.4 Mean of Integrity based on Title condition

4.4 Relationship of identified characteristics in RQ1, and identified quality factors in RQ2 (RQ4 and RQ5)

In order to identify if the survey items were grouped in a meaningful way, factor analysis was used. Factor analysis is common way to conduct a data reduction and exploration of basic factors in the data (Lederer et al., 2000). In order to conduct factor analysis, Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin test were performed, and results were found satisfactory. For the rotation and extraction methods of factor analysis, Direct Oblimin and Principal axis factoring methods were employed respectively. In the process, the factors of structures were investigated by evaluating items' factor loading values. Factor loading value of 0.3 is acceptable for reliable results (Steel & Torrie, 1960). The items with more than 0.3 factor loading values and the place of items in the constructs were presented in Table 4.28 and Table 4.29 respectively. As the survey includes both the characteristics and quality factors of B2C mobile applications, each factor analysis was done separately.

RQ4- Relationship of B2C Mobile Characteristics

After the factor analysis, 4 items were eliminated since their factor loadings were below the threshold value (0.3). Moreover, NAV4 item was found to have multiple loadings on two factors. Thus, this item was eliminated. The eliminated items were shown in Table 4.21. As a result, 17 items remained (PRE: 5 items; NAV: 4 items; PUR: 8 items).

Table 4.21 Constructs & Eliminated Items

Constructs	Eliminated Items
Presentation	PRE1
Navigation	NAV4
	NAV6
Presentation	PUR3
	PUR5

Reliability analysis displays the internal consistency within the constructs. It was conducted by analyzing Cronbach's Alpha values of the constructs in item-basis within the constructs. The Alpha values of PUR, NAV, and PRE 0.73, 0.63, and 0.64 respectively. As a result of this, PUR construct is more reliable as its value was greater than 0.70 (Steel & Torrie, 1960). NAV and PRE constructs have acceptable Cronbach Alpha values as their value were greater than 0.60. Besides, the overall reliability of the model was 0.75 which presents the model was found significantly reliable.

Convergent Validity

The validity of survey items were analyzed by following the Fornell and Larcker's (1981) process. This process includes three different measurements; item reliability, composite reliability, and average of extracted variance. Considering the item reliability, 0.4 or higher value is acceptable (Hulland, 1999). From the results in Table 4.22, it can be seen that all items are greater than 0.4. Secondly, each construct's composite reliability should be higher than 0.70 (Nunnally & Bernstein, 1994). As shown in Table 4.22, all composite reliability values are between 0.72 and 0.80. Finally, AVE value is expected to be 0.5 or higher for each construct (Segars, 1997).

Table 4.22 displays that this value is calculated as at least .051. As a result, validity of used items is provided.

Table 4.22 Validity of Survey Items

Construct	Composite	AVE	Item	Factors Loadings
NAV	0,80	0,57	NAV1	0,50
			NAV2	0,85
			NAV3	0,84
PRE	0,72	0,51	PRE2	0,60
			PRE3	0,54
			PRE4	0,41
			PRE5	0,53
			PRE6	0,45
			NAV5	0,77
PUR	0,80	0,54	PUR1	0,52
			PUR2	0,54
			PUR4	0,54
			PUR6	0,57
			PUR7	0,69
			PUR8	0,72
			PUR9	0,76

Discriminant Validity

Discriminant validity is an indicative of one construct diverging from others. In order to examine, all constructs' square root of AVE values should be compared with constructs' correlation values. In order to claim discriminant validity is achieved, each construct' square root of AVE value should be higher than correlation of that construct with other constructs. In order to display discriminant validity is achieved; correlation matrix was designed as shown in Table 4.23.

From the results as shown in Table 4.23, discriminant validity was achieved.

Table 4.23 Discriminant validity test results

	NAV	PRE	PUR
NAV	**0,76**		
PRE	0,26	**0,56**	
PUR	0,29	0,38	**0,58**

Structural Model

Up to this point, constructs and items were obtained with factor analysis. Moreover, reliability analysis, convergent validity and discriminant validity techniques were confirmed. As a result, 3 constructs and 17 items were left.

In this part of the study, previously proposed model belonging to hypothesis and relationships among constructs were tested with using SmartPLS software. T values were gathered for the hypotheses which were taken into consideration, and

significance of the relationship was determined using these values. The results of hypotheses were shown in Table 4.24.

Table 4.24 Hypothesis Analysis

Hypothesis	Relations	β Value (PathCoefficients)	t Values	Conclusion
H1	NAV->PRE	0,27*	2,02	Supported
H2	NAV->PUR	0,14	0,80	Not Supported
H3	PRE->PUR	0,31**	3,91	Supported

**p< 0.05, **p< 0.001*

As can be seen from the Table 4.24, 2 of the hypothesis were supported. The effect of presentation on purchasing (β=0.31, $p < 0.001$) was significant. Moreover, the effect of navigation on presentation construct (β=0.27, $p < 0.05$) was significant. However, the effect of navigation on purchasing construct was not significant. Figure 4.5 presents the relationships of structural model.

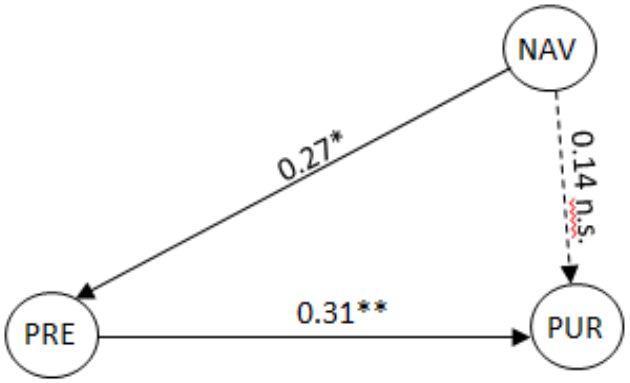

Figure 4.5 Structural Model of B2C Mobile Applications Characteristics

RQ5- Relationship of B2C Mobile Quality Factors

The results of factor analysis show that all items' factor loadings are above the threshold value (0.3). However, there were five items, M1, R1, U1, C1, and C2, found to have multiple loadings on two factors. Therefore, those items were eliminated. As a result, 25 items were remained (M: 7 items; FS: 4 items; PE: 2 items; S: 4 items; U: 3 items; R: 5 items). Although two-factor-loaded construct (PE) might raise a doubt, it was validated by reliability analysis.

Reliability analysis displays the internal consistency within the constructs. It was conducted by analyzing Cronbach's Alpha values of constructs in item-basis within the constructs. The Alpha values of M, FS, PE, S, U, and R were 0.88, 0.73, 0.76,

0.77, 0.73, and 0.79 respectively. As a result of this, all constructs were found reliable as their values were greater than 0.70 (Steel & Torrie, 1960). Besides, the overall reliability of the model was 0.93 which presents the model was found significantly reliable.

Convergent Validity

The validity of B2C mobile quality factors survey items were analyzed just like the process of validity of B2C mobile characteristics. Considering the item reliability, apart from the R2 and U4 items, all of the items were above 0.70 which means the suggested limit in the literature (Hair, Black, Babin, Anderson & Tatham, 2003). As R2 and U4 items are below 0.4, the reliability of it is acceptable. As can be seen from the Table 4.25, all composite reliability values are between 0.84 and 089. Moreover, the AVE values for each construct are above 0.5. Therefore, validity of used items is provided.

Table 4.25 Validity of Survey Items

Construct	Composite Reliability	AVE	Item	Factor Loadings
FS	0,87	0,62	FS1	0,85
			FS2	0,74
			FS3	0,76
			S2	0,79
M	0,89	0,66	M2	0,77
			M3	0,75
			M4	0,74
			M5	0,81
			P1	0,78
			P2	0,80
			P3	0,78
PE	0,89	0,80	PE2	0,87
			PE3	0,92
R	0,86	0,55	R2	0,61
			R3	0,76
			R4	0,78
			PE1	0,78
			U3	0,77
S	0,85	0,59	S1	0,76
			S3	0,79
			S4	0,76
			U5	0,77
U	0,84	0,64	U2	0,84
			U4	0,68
			U6	0,86

Discriminant Validity

As can be seen from Table 4.26, discriminant validity is achieved as each construct's square root of AVE value was higher than correlation of that construct with other constructs.

Table 4.26 Discriminant validity test results

	FS	M	PE	R	S	U
FS	**0,79**					
M	0,46	**0,78**				
PE	0,30	0,46	**0,90**			
R	0,55	0,58	0,50	**0,74**		
S	0,45	0,55	0,50	0,58	**0,77**	
U	0,51	0,51	0,48	0,55	0,53	**0,80**

Structural Model

After checking reliability analysis, convergent validity and discriminant validity techniques were confirmed, 6 constructs and 25 items were left.

In this part of the study, the previously proposed model belongs to hypothesis and relationships among constructs were tested by using SmartPLS software. T values were gathered for the hypotheses which were taken into consideration, and significance of the relationship was determined using these values. The results of hypotheses were shown in Table 4.27.

Table 4.27 Hypothesis Analysis

Hypothesis	Relations	β Value (PathCoefficients)	t Values	Status
H1	M-> U	0,51**	7.28	Supported
H2	M-> S	0,38**	3,54	Supported
H3	M-> PE	0,29*	2,91	Supported
H4	M-> P	X	x	Not Measured
H5	M-> R	0,40**	3,78	Supported
H6	M-> C	X	x	Not Measured
H7	M-> FS	0,28*	2,90	Supported
H8	U-> S	0,34*	3,22	Supported
H9	U-> PE	0,34*	3,24	Supported
H10	U-> FS	0,37**	3,90	Supported
H11	U-> P	X	x	Not Measured
H12	U-> R	0,35**	3,44	Supported
H13	U-> C	x	x	Not Measured

**p< 0.05, **p< 0.001*

As can be seen from the Table 4.27, the effect of maintainability on portability and compatibility, and the effect of usability on portability and compatibility were not measured since these constructs were eliminated after factor analysis. Structural model test results show that 9 hypothesis were significant. The effect of maintainability (M) on all constructs was tested except for the portability (P) and compatibility (C). From the results maintainability (M) has significant effect on

usability (β=0.51, p < 0.001), security (β=0.38, p < 0.001), performance efficiency (β=0.29, p < 0.05), reliability (β=0.40, p < 0.001), and functional suitability (β=0.49, p < 0.05). Moreover, the effect of usability (U) on security (S), performance efficiency (PE), functional suitability (FS), and reliability (R) constructs were tested. From the results usability (U) has significant effect on security (β=0.34, p < 0.05), performance efficiency (β=0.34, p < 0.05), reliability (β=0.35, p < 0.001), and functional suitability (β=0.37, p < 0.001). Figure 4.6 presents the only supported relationships of structural model.

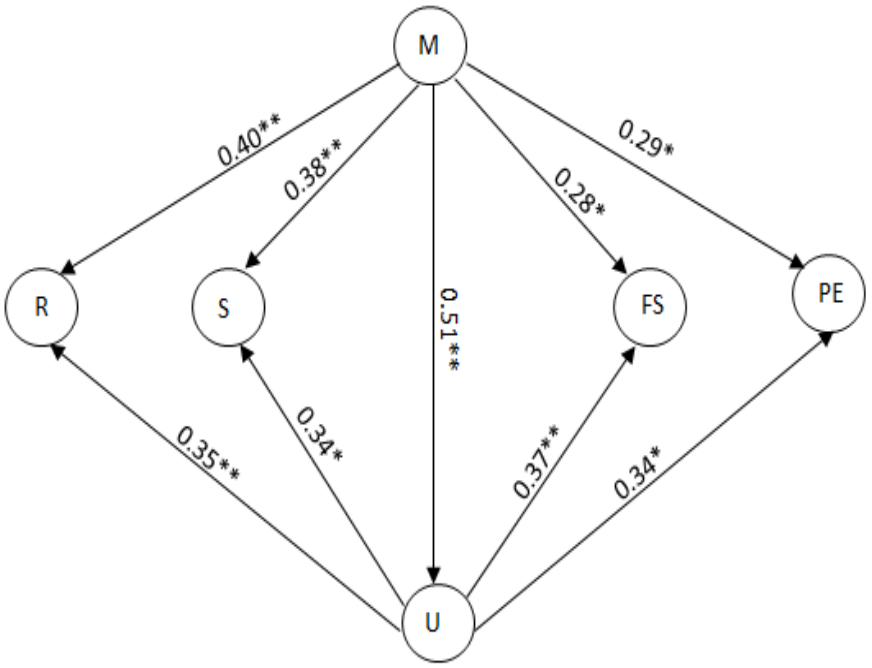

Figure 4.6 Structural Model of B2C Mobile Applications Quality Factors

Table 4.28 Factor Loading Values for B2C Mobile Characteristics

Factors	1	2	3
PUR9	0,71		
PUR7	0,67		
PUR8	0,67		
PUR6	0,6		
PUR4	0,53		
PUR10	0,42		
PUR1	0,34		
PUR2	0,32		
PRE3		0,63	
PRE4		0,57	
PRE2		0,44	
NAV5		0,4	
PRE5		0,37	
PRE6		0,36	
NAV3			0,63
NAV2			0,48
NAV1			0,4

Table 4.29 Factor Loading Values for B2C Mobile Quality Factors

Factors	1	2	3	4	5	6
M5	0,76					
P2	0,74					
P3	0,73					
M4	0,67					
M3	0,57					
P1	0,56					
M2	0,55					
FS1		0,82				
FS2		0,61				
FS3		0,51				
S2		0,48				
PE2			0,91			
PE3			0,5			
S3				0,86		
S4				0,66		
S1				0,42		
M1				0,36		
U5				0,3		
U2					0,66	
U6					0,56	
U4					0,41	
R3						0,71
R4						0,65
PE1						0,61
U3						0,38
R2						0,32

4.5 Need for B2C Mobile Application Quality Model (RQ6)

In order to answer the RQ6, both literature review and semi-structure interview were conducted. From the literature review on existing software quality models for mobile applications, results show that there is a need for analyzing quality of B2C mobile applications as most of the mobile applications studies are based on ISO 9126 quality model.

To validate literature review results, question 4, 7 and 8 were asked to participants in the interview.

Question 4: What is the meaning of B2C mobile application quality for you?

According to results of the interview coding, having positive features or factors of B2C mobile applications, and removing negative features or factors of B2C mobile applications make the qualified application for the participants. Moreover, two of the participants mentioned that the brand-name is also important for them. If they know the company in a better way, they already think that application is qualified.

Question 7: Do you use any criteria when assessing B2C mobile application?

From the mobile developer perspective, according to the results, mobile developers do not have any document to follow and analyze quality of the applications. They basically control if the application working is stable, and looking users' comments after they are produced on market.

From the other participants' perspective, they mostly download applications based on friends' suggestions, users' comments, and download ranking.

The combined results for the interview questions 7 are shown in Table 4.30.

Table 4.30 Participants' Answers to the Interview Question 7

Participants	Answers
Mobile Developers	There is not any document to assess the applications. Following the applications work on stable, and there is not any wireless connection problems. Also, modular structure for coding is used if there is any change request happens.
Software Developers, IT Experts, End Users	Friends' suggestions, user comments, and download ranking are the criteria that they follow. Moreover, sample of presentation or graphics are also give an idea to download or not.

Question 8: Considering star rate on application store, will it be helpful to have more items about B2C mobile application?

Table 4. 31 Participants' Answers to the Interview Question 8

Participants	Yes	No	Not Sure
Mobile Developers	1	2	
Software Developers	2		
IT Experts	2		1
End-Users	2		
n	7	2	1

Table 4.31 illustrates the participants' answers to interview question 8. From the Table 4.31, 7 participants agree with the idea to have more quality items on application store.

One of interviewees mentioned the need of such mechanism stating that:

"There is not anything out of 5 stars. When you give lowest points, it brings the above. Therefore, star rate is not useful anymore. However, it would be good to have such a detailed way" (Interviewee 4, ITE / Opinion6.1)

Another interviewee also mentioned the importance of such mechanism considering the waste of time by stating that:

"It would be useful, and would be the first place that I would look for. I may spend a lot of time for an application. It will save me spending that time" (Interviewee 6, ITE / Opinion6.2)

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Introduction

The aim of the present study is to provide a method to analyze the quality of the B2C mobile applications based on the mobile specific characteristics and quality factors, and sub-factors based on IS0 25010 software product quality model. The main focus was to identify important characteristics, quality factors, and sub-factors of B2C mobile applications. The relationship of the identified characteristics and relationship of the identified quality factors were also investigated in the study. Besides, the differences among participants who were mobile developers, software developers, information technology experts, and end-users were studied in terms of their perception of B2C mobile characteristics and quality factors and sub-factors. In order to provide a detailed description of the situation, a mixed-method research design was conducted. Data from a survey and interviews were obtained in different phases. As they are complementary, the interpretation consisted of combined data. In this chapter, discussion of the results of the study is presented first, then, suggestions are offered for future studies.

5.2 Discussion

As mentioned in the "Introduction" chapter, this study aims to define the important characteristics and quality factors of B2C mobile applications. The differences among participants were also examined as participants of the study included developers and end-users. Furthermore, relationship of the characteristics and quality factors were analyzed by structural equation modelling.

In accordance with the purpose of the study, the following research questions were posed:

- RQ1: **What are the important characteristics of B2C mobile applications?**

- RQ2: **What are the most important quality requirements or factors set for B2C mobile applications?**
- RQ3: **What is the difference among Mobile Developers (MD), Software Developers (SD), Information Technology Experts (ITE), and End-Users (EU) based on their perceptions about the B2C mobile application characteristics, quality factors, and sub-factors?**
- RQ4: **What is the relationship between the characteristics identified in RQ1?**
- RQ5: **What is the relationship between the factors identified in RQ2?**
- RQ6: **Do existing mobile application quality models meet the need of B2C mobile application quality?**

Research flow of this study has started with the literature review on existing software quality models for mobile applications. Results show that there is a need for analyzing quality of B2C mobile applications as most of the mobile applications studies have lack of criteria or they are based on ISO 9126 quality model which is not valid anymore. Moreover, in the semi-structured interview, participants mentioned that they did not use any quality model to assess the B2C mobile applications which show the need of such model. With this literature review and semi-structured interview results, we have addressed RQ6. Therefore, it can be said that;

> *"Existing mobile application quality models do not meet the need of B2C mobile application quality"*

In order to overcome the inadequacy of the B2C quality model, developing a new quality model or transforming the existing quality models with some improvements could be the solutions. As developing a new quality model brings the validity issue of the study, this study transforms and improves the Garofalaki, Stefani, Stefanis and Xenos' study to define characteristics of B2C mobile applications as a solution. In terms of the quality factors of B2C, ISO 25010 quality model was chosen as a baseline. After improving the Garofalaki, Stefani, Stefanis and Xenos' study, and using the ISO 25010 quality model, an online survey was conducted with 34 mobile developers, 34 software developers, 23 end-users, and 34 IT experts. With the online survey results, Research Question 1 and 2 have been addressed.

From the results, clarity, appropriateness of presentation, product's description, and use of graphics are important characteristics of the presentation dimension. As for the navigation dimension, navigation mechanism, user oriented hierarchy, and access keys are the important characteristics. Considering the purchasing dimension, security mechanism, accuracy of the operations, authentication, operation response time, error recovery, and pricing mechanism are the important characteristics.

In terms of the quality factors; security, reliability, usability, functional suitability, performance efficiency, maintainability, and compatibility are the important main

quality factors. Considering the quality sub-factors; functional correctness, recoverability, confidentiality, availability, functional appropriateness, fault tolerance, maturity, integrity, authenticity, time-behavior, user error protection, user interface aesthetics, functional completeness, accountability, modifiability, testability, and learnability are the important sub-factors.

Overall assessment of literature review results and results of the present study show that some of the important factors which are security, functional suitability and performance efficiency were not mentioned in traditional quality studies but in ISO25010 quality model. From the results, it is apparent that security is an important quality factor as the application includes the money transaction. Functional suitability and performance efficiency are the other important quality factors for the participants since the users expect accurate and quick operation in their applications.

In order to examine the differences among participants to address the Research Question 3, Anova test was used. Results show that use of graphics, appropriateness of presentation, functional suitability, and integrity items could be significantly different among MD, SD, ITE, and EU. To be clearer, there is a significant difference between MD and SD, ITE, EU in terms of use of graphics characteristic. As for the appropriateness of presentation characteristic, there is a significant difference between SD and MD, EU. In terms of functional suitability quality factor, there is a significant difference between EU and SD, ITE. As for the integrity quality sub-factor, there is a significant difference between ITE and MD, EU. The rest of the B2C mobile characteristics, quality factors, and quality sub-factors were not significantly different among MD, SD, ITE, and EU.

The results of the differences among participants are shown in Table 5.1. As it can be seen from the Table 5.1, the importance degree of use of graphics is higher for MD with respect to SD, ITE, and EU. The reason of this result can be mobile developers' opinion toward presentation. They could consider presentation must be attractive to get more users. Moreover, mobile developer might consider that using small size graphics can affect the performance of the application. For SD, appropriateness of presentation is important with respect to MD and EU. As for the ITE, integrity is important with respect to MD and EU. Finally, functional suitability's importance degree is less for the EU with respect to SD and ITE.

Table 5. 1 Differences among Participant Groups

Participant Groups	**Mobile Developer (**)**	**Software Developer (**)**	**IT Expert (**)**	**End User (**)**
Mobile Developer (*)	-	Use of Graphics (*)	Use of Graphics (*)	Use of Graphics (*)
Software Developer (*)	Appropriateness of Presentation (*)	-	-	Appropriateness of Presentation (*)
IT Expert (*)	Integrity (*)	-	-	Integrity (*)
End User (*)	-	Functional Suitability (**)	Functional Suitability (**)	-

(*) First column of the participants' perceptions toward the item has higher mean value with respect to first row of the participants' perceptions.
(**) First row of the participants' perceptions toward the item has higher mean value with respect to first column of the participants' perceptions.

As one of the aim of this study is to reveal the relationship of the characteristics identified for RQ1, and the relationship of the quality factors identified for RQ2, research hypotheses were defined as below;

To explore the relationship of the B2C Mobile Characteristics;

- H1. Navigation (NAV) construct has a positive influence on Presentation (PRE) construct.
- H2. Navigation (NAV) construct has a positive influence on Purchasing (PUR) construct.
- H3. Presentation (PRE) construct has a positive influence on Purchasing (PUR) construct.

The relationships of navigation and presentation constructs were examined in H1. Results show that, if the users consider navigation mechanism is good, it positively affects their opinion toward presentation of the application. However, there is not significantly relationship between navigation and purchasing therefore H2 was not supported. To examine the relationships of presentation and purchasing constructs, H3 were examined. From the results, if the users consider presentation mechanism is good, it positively affects their opinion toward purchasing mechanism of the applications.

The results of the structural model of B2C mobile characteristics are shown in Table 5.2.

Table 5. 2 Structural Model of B2C Mobile Characteristics' Results

Constructs	Presentation	Purchasing
Navigation	*	-
Presentation	-	**

(*) $p < 0.05$: statistically significant
(**) $p < 0.001$: statistically highly significant

To show the relationship of the B2C Mobile Quality Factors;

- H4. Maintainability (M) construct has a positive influence on Usability (U) construct.
- H5. Maintainability (M) construct has a positive influence on Security (S) construct.
- H6. Maintainability (M) construct has a positive influence on Performance Efficiency (PE) construct.
- H7. Maintainability (M) construct has a positive influence on Portability (P) construct.
- H8. Maintainability (M) construct has a positive influence on Reliability (R) construct.
- H9. Maintainability (M) construct has a positive influence on Compatibility (C) construct.
- H10. Maintainability (M) construct has a positive influence on Functional Suitability (FS) construct.
- H11. Usability (U) construct has a positive influence on Security (S) construct.
- H12. Usability (U) construct has a positive influence on Performance Efficiency (PE) construct.
- H13. Usability (U) construct has a positive influence on Functional Suitability (FS) construct.
- H14. Usability (U) construct has a positive influence on Portability (P) construct.
- H15. Usability (U) construct has a positive influence on Reliability (R) construct.
- H16. Usability (U) construct has a positive influence on Compatibility (C) construct.

In order to examine the relationships of Maintainability on all constructs, H4, H5, H6, H7, H8, H9, and H10 were evaluated. From the results, H7 and H9 were not measured as they were eliminated after factor analysis. However, H4, H5, H6, H8, and H10 show that maintainability positively affects on all other constructs, which are Usability, Security, Performance Efficiency, Reliability and Functional Suitability respectively. Considering the maintainability which directly influences on the application's properties is an important quality factor, the results was not a surprise.

To address the H11, H12, H13, H14, H15, and H16, relationships of Usability on all constructs were examined. From the results, H14 and H16 were not measured as they were eliminated after factor analysis which was mentioned before. However, H11, H12, H13, and H15 show that usability positively affects on Security, Performance Efficiency, Functional Suitability, and Reliability respectively. The reason behind this result can be the users' performance while using the application. In other words, if the application is user-friendly, it will decrease the user errors. Thus, it is possible to be more efficient, functional, reliable and secure.

The results of the structural model of B2C mobile quality factors are shown in Table 5.3.

Table 5. 3 Structural Model of B2C Mobile Quality Factors' Results

Constructs	**Usability**	**Security**	**Performance Efficiency**	**Reliability**	**Functional Suitability**
Maintainability	**	**	*	**	*
Usability	-	*	*	**	**

(*) $p < 0.05$: statistically significant
(**) $p < 0.001$: statistically highly significant

The surprising results can be listed as below;

- **The Importance of Portability Factor:** Although portability is an important in ISO 25010 quality model, the results indicate that it is not a critical factor since it depends on the device's operating system. Moreover, most of the applications in Google store are also available in Apple store, or vice versa. Thus, participants might consider it is not a critical quality factor as they can reach any application not only from Google store but also from Apple store.

- **Security Certification:** As mobile users feel insecure on mobile application, they need to get more information about security issues. In order to do that application should have security certificate information.

- **Brand-Name Importance:** Brand-Name is an important element that leads users to think that the application has enough quality at least from the security

point of view. Therefore, no matter how much effort companies spend on the quality of the application, they should not forget the advertisement of the company.

- **Solutions of Usability Problems:** It is not a surprise that usability is an important quality factor, but usability solutions gathered from participants were surprising. Some solutions are below;
    - Application should provide information if there is any operation going on,
    - If there have some dependencies on other factors like internet connection speed, user should be informed about that,
    - Navigation mechanism should have a standard that must be followed by every company. Thus, end-users do not need to waste time for the first time they use the application.
    - The mostly used key characters like "@" should be in the first screen of the virtual keyboard.
- **Differences among Participants:** It was expected to have more differences among the end-users, the mobile developers, the software developers, and the IT experts since there are some technical quality concepts in the questionnaire. However, the results indicate that there are not significant differences among participants. The reason behind this could be the computer literacy of end-users. Purposive sampling was used for this study, and most of the end-users were graduated from the computer related field. Moreover, the significant differences among the participants were surprising. It was not expected to get significant differences between end-users and software developer, end-users and IT experts about the functional suitability factor since end-users also consider that it is an important factor that gathered from interview results. Furthermore, appropriateness of presentation was expected to get higher importance degree for end-users and mobile developers. However, results indicate that it is an important quality factor for software developers in comparison to end-users and mobile developers.

5.3 Conclusion

It is important to note that the results of the study are not expected to provide generalizable method for quality characteristics and factors of all mobile applications. However, the results obtained through the interviews, questionnaire and statistical analysis would provide valuable insights about the most important quality characteristics and quality factors; differences among both various developers' and end-users' perceptions on quality factors and characteristics, and the relationship between the quality factors. We believe that the results would enhance understanding about the most influential aspects of qualified B2C mobile applications.

As discussed in introduction and literature review part, there are not so many studies about quality assessment of B2C mobile applications. Although there are some companies that show their products' quality with their performance results, there is no standard about that. It would be good if International Organization for Standardization produce specific standard for B2C mobile applications quality. As for the Turkey, Turkish Standards Institution (TSE) might be the leader about that issue. TSE might set a unit to assess the quality of B2C mobile applications. The unit could share the quality criteria on their websites so that everyone can reach. If a company's product has enough quality criteria, the company can get authorization certificate from the TSE, and users will have a chance to know the product that they use has enough quality or not.

To assess the quality of B2C mobile applications basically, companies should pay more attention on the below factors;

- **Security:** As B2C mobile applications have banking operations, users need to feel that application does not have any security problems. In order to provide that, application must have a security certification which is provided another company that has a brand-name. As an example, TÜBİTAK might be the leader about security certification as it already produces SSL certificate for government's unit.

- **Usability:** Considering limitations of mobile devices like limited screen size, applications need to be more usable in comparison to desktop computers. To solve the usability problems, usability test must be conducted. Usability test results for the application might give an idea about the usability problems. Moreover, navigation mechanism is also important that can be considered in the usability factor. A standard navigation mechanism that is followed by every company makes the application much more easy to use.

- **Presentation:** To get users attention, presentation mechanism must be attractive and simple. If users do not like the appearance of the application, they are more inclined to delete the application.

- **Performance:** As users expect to get quick response from the application, performance issue is also important. For this purpose, developers might use small size graphics in the application which affect the performance. Moreover, users must be informed if any operation is going in the application. Users must also be informed if some operations have dependency on other factors. As an example, if the operation cannot be performed because of the internet connection, users must be informed about that. If they do not know what is going on behind, their opinions about the application will not be good. Furthermore, performance tests must be conducted to measure the speed and efficiency of the application.

- **Maintainability:** As stated in the results part, maintainability is one of the important quality factors for B2C mobile applications. Developing an application is actually the simple part. The challenge comes with the maintainability. Companies must provide maintainability of the application,

and any defects or problems should be reduced immediately. As an advice, one of the quality assurance team members should follow the defects that are commented by the users in the application store. The quality team member should send defects immediately to the mobile development team. It would be good if the team follows the Agile methodology to response and solve defects quickly. Moreover, it would motivate the quality assurance team and development team if there is a service level agreement about solving the products' problems.

Moreover, companies should set a quality assurance team in order to assess their product's quality. The team must follow set of rules and criteria which were mentioned above as basically. Also, the team members might use checklist to set an assessment rate for their product. The mean scores of the characteristics and quality factors that were given in results part might be used as a ratio for each quality characteristics and quality factors. After conducting more research about the specific fields of B2C mobile applications, a quality model for B2C mobile applications might be formed considering the specific differences among those applications.

5.4 Limitations and Suggestions for Future Studies

In this research a method to identify B2C mobile application characteristics and quality factors has been proposed. Our results show that it is helpful for not only mobile application developer but also for end-users; however, more research needs to be undertaken as sample size is limited for the reliability of the proposed study. Even though, the proposed model seems to be significant for the collected samples; more research should be conducted to investigate its generalizability in terms of reliability and validity issues. Further research should be carried out to investigate the benefits of the proposed model. Furthermore, differences among gender groups, age groups, and work experience groups could not be measured as the numbers of those groups are not equally distributed. Therefore, future studies may consider studying differences between those groups. Also, it could be good to interview with female end-users as they are usually considered to be more inclined to shopping. Besides, there might be some differences based on participants' socio-economic status. Thus, future studies may include the socio-economic status of the participants.

Moreover, there is a statistical reliability for the questionnaire but there might be some differences about the understanding of questions and concepts among the participants. However, participants were able to answer the interview questions with the same meaning as they have a chance to get explanation about questions and concepts even though there is no statistical reliability for the interview. As an example, personalization was defined as providing users to change mobile application according to their requirement. However, some participants might have been considered that application gets the users' profile according to their use and response user considering their profile. Thus, future studies should investigate if there is such a misconception about the concepts among participants. Furthermore, future studies may use characteristics and quality factors defined in this study for different fields. As some B2C mobile applications may not have shopping function

like financial applications, the constructs proposed in this study might be reconsidered for different type of B2C applications. As an example, specific properties of financial applications might be quality assessment characteristics. Therefore, it would be good to consider some specific characteristics for B2C applications. Choosing a specific field on B2C applications and conducting a case study on this field would be more beneficial.

As a future study, it could be valuable to conduct the same study with increased number of participants for more reliable results as we had 115 participants for quantitative and 10 participants for the qualitative study. Also, it could be possible to use different scenarios and specific fields for the future investigations.

Finally, studies on whether the proposed model can meet the requirements of other mobile applications can be planned. For example, if the proposed model could be used for B2B mobile applications' characteristics and quality factors deserve further research.

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APPENDICES

APPENDIX A: QUESTIONNAIRE (IN TURKISH)

B2C Mobil Uygulamaları Kalite Faktörleri Anketi
Bu anket B2C mobil uygulamaların kalitesine etki eden faktörleri belirlemek amacıyla hazırlanmıştır. Bu çalışma dört bölümden oluşmaktadır. İlk bölüm Katılımcıların Demografik bilgilerini, İkinci bölüm B2C Mobil Uygulamalarının özelliklerinin önem düzeyini, Üçüncü bölüm B2C Mobil Uygulamalarının Kalite Ana Faktörleri'nin önem düzeyini, Dördüncü bölüm ise B2C Mobil Uygulamalarının Kalite Alt Faktörleri'nin önem düzeyini ölçmek için tasarlanmıştır. Vereceğiniz cevaplar gizli tutulacaktır. Katılımınız için teşekkür ederiz.

1. Bölüm – Katılımcı Bilgileri

1. Yaşınız: *

Lütfen yanıtınızı buraya yazınız:

2. Cinsiyetiniz: *

Lütfen aşağıdakilerden yalnız birini seçiniz:

◯ Kadın

◯ Erkek

3. Mezun Olduğunuz Okul: *

Lütfen yanıtınızı buraya yazınız:

4. Mezun Olduğunuz Bölüm: *

Lütfen yanıtınızı buraya yazınız:

5. İş Yerinizdeki Unvanınız: *

Lütfen aşağıdakilerden yalnız birini seçiniz:

◯ Mobil Geliştirici

◯ Yazılım Geliştirici

◯ Bilişim Teknolojileri Uzmanı

◯ Diğer (lütfen belirtiniz)

6. “Diğer” için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

7. Deneyim Süreniz: *

Lütfen aşağıdakilerden yalnız birini seçiniz:

◯ 0-1 Yıl

◯ 1-3 Yıl

◯ 3 Yıl ve üzeri

8. Araştırmanın sonucundan haberdar olmak isterseniz, iletişim için e-posta adresiniz:

Lütfen yanıtınızı buraya yazınız:

2. Bölüm – B2C Mobil Uygulamaları Özellikleri

Bu bölümde B2C Mobil Uygulamalarının özellikleri Sunum, Navigasyon ve Satın Alma başlıkları altında belirtilmiştir. Deneyiminiz doğrultusunda bir B2C mobil uygulamasının en önemli/önemsiz özellikleri hangileridir? Uygun bulduğunuz seçeneği işaretleyiniz. (1 –Hiç Önemli Değil, 2 – Düşük Seviyede Önemli, 3 – Orta Seviyede Önemli, 4 – Yüksek Seviyede Önemli, 5 – Kritik Seviyede Önemli, 6- Fikrim Yok)

9. Sunum (Presentation): *

Lütfen her bir öge için uygun yanıtı seçiniz:

	1	2	3	4	5	6
Ürünün tanımı (Product’s description)[1]						
Metnin kullanımı (Use of Text) [1]						
Renklerin kullanımı (Use of Colors) [1]						
Grafiklerin kullanımı (Use of Graphics) [1]						
Sunumun açıklığı (Clarity) [1]						
Sunumun Uygunluğu (Appropriateness of Presentation)						
Diğer (belirtiniz)						

10. “Diğer” için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

11. Navigasyon (Navigation): *

Lütfen her bir öge için uygun yanıtı seçiniz:

	1	2	3	4	5	6
Navigasyon Mekanizması (Navigation Mechanism) [1]						
Erişim tuşları (Access keys) [1]						
Linklerin kullanımı (Use of Links) [1]						
Yardım özelliği (Help) [1]						
Geri alma fonksiyonları (Undo functions) [1]						
Kullanıcı odaklı hiyerarşi (User oriented hierarchy) [1]						
Diğer (belirtiniz)						

10. "Diğer" için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

11. Satın Alma (Purchasing): *

Lütfen her bir öge için uygun yanıtı seçiniz:

	1	2	3	4	5	6
Alışveriş sepeti (Shopping cart – Metaphor) [1]						
Güvenlik mekanizması (Security mechanism) [1]						
Fiyatlandırma mekanizması (Pricing Mechanism) [1]						
Alternatif ödeme seçenekleri (Alternative payment methods) [1]						
Kullanıcı doğrulama (Authentication) [1]						
Kişiselleştirme (Personalization) [1]						
Hata düzeltme (Error recovery) [1]						
Hata toleransı (Errors tolerance) [1]						
İşlem Yanıt süresi (Operation Response time)						
İşlemlerin doğruluğu (Accuracy of the operations)						
Diğer (belirtiniz)						

10. "Diğer" için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

3. Bölüm – B2C Mobil Uygulamaları Kalite Ana Faktörleri

Bu bölümde B2C Mobil Uygulamalarının kalite ana faktörleri verilmiştir. Deneyiminiz doğrultusunda bir B2C mobil uygulamasının en önemli/önemsiz kalite ana faktörleri hangileridir? Uygun bulduğunuz seçeneği işaretleyiniz. (**1** –Hiç Önemli Değil, **2** – Düşük Seviyede Önemli, **3** – Orta Seviyede Önemli, **4** – Yüksek Seviyede Önemli, **5** – Kritik Seviyede Önemli, **6-** Fikrim Yok)

	1	2	3	4	5	6
Fonksiyonel Uygunluk (Functional Suitability): Uygulamanın görevleri/ihtiyaçları karşılamak için sağladığı fonksiyonların düzeyi.						
Güvenirlilik (Reliability): Uygulamanın düzgün çalışma halini koruyabilme düzeyi. [2]						
Performans Verimliliği (Performance efficiency): Uygulamanın ihtiyaç duyulan ölçüde yeterli performansla çalışabilme düzeyi.						
Kullanılabilirlik(Usability): Uygulamanın kullanıcı için kullanım kolaylığı sağlama düzeyi. [2]						
Güvenlik (Security): Uygulama öğelerinin zararlı ve yetkisiz erişimlerden korunma düzeyi. [2]						
Uyumluluk(Compatibility):Birden fazla uygulama bileşeninin gerekli fonksiyonları sağlarken uyumlu çalışma düzeyi						
Taşınabilirlik (Portability):Uygulamanın farklı çalışma ortamlarına uyum sağlayabilme düzeyi. [2]						
Sürdürülebilirlik-Bakılabilirlik(Maintainability): Uygulamanın değişiklik yada düzeltme isteklerinin ilgilenen kişiler tarafından etkin şekilde yapılma düzeyi. [2]						
Diğer(belirtiniz):						

11. “Diğer” için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

4. Bölüm – B2C Mobil Uygulamaları Kalite Alt Faktörleri

Bu bölümde B2C Mobil Uygulamalarının Kalite Alt Faktörleri verilmiştir. Deneyiminiz doğrultusunda bir B2C mobil uygulamasının en önemli/önemsiz kalite alt faktörleri hangileridir? Uygun bulduğunuz seçeneği işaretleyiniz. (**1** –Hiç Önemli Değil, **2** – Düşük Seviyede Önemli, **3** – Orta Seviyede Önemli, **4** – Yüksek Seviyede Önemli, **5** – Kritik Seviyede Önemli, **6-** Fikrim Yok)

	1	2	3	4	5	6
Fonksiyonel Uygunluk(Functional Appropriateness): Uygulamadaki görevleri yerine getirmek için gerekli olan fonksiyonların uygunluk düzeyi.						
Fonksiyonel Doğruluk (Functional Correctness): Uygulamadaki işlevin doğru olma düzeyi.						
Fonksiyonel Bütünlük (Functional Completeness): Uygulamadaki fonksiyonların görevleri/ihtiyaçları kapsama düzeyi.						
Olgunluk(Maturity): Uygulamanın güvenirlilik ihtiyaçlarını karşılama düzeyi.						
Bulunabilirlik/Ulaşılabilirlik(Availability): Uygulamanın ihtiyaç halinde kullanımının sağlanabilir olma düzeyi. [2]						
Hata Toleransı (Fault tolerance): Uygulamanın donanım ve yazılım hatalarına 101ke fo istendiği gibi çalışabilme düzeyi. [2]						
Kurtarılabilirlik(Recoverability): Olası hata durumunda etkilenen veriyi kurtarma düzeyi. [2]						
Zaman Davranışı (Timebehaviour): Uygulamanın işlev için gerekli olan tepki ve işlem süresi. [2]						
Kaynak Kullanımı (Resource Utilization): Uygulama tarafından donanımsal kaynakların kullanılma düzeyi. [2]						
Kapasite (Capacity): Uygulamanın gereksinimleri karşılamak için gerekli olan maksimum limit düzeyi.						
Tanınırlık Uygunluğu (Appropriateness Recognisability): Uygulamanın kullanıcının ihtiyaçlarını karşılamadaki uygunluğunun kullanıcı tarafından tanınırlık düzeyi.						
Öğrenilebilirlik (Learnability): Kullanıcının						

	1	2	3	4	5	6
görevleri yerine getirmesi için gerekli olan öğrenme eforu düzeyi. [2]						
İşletilebilirlik (Operability): Uygulamadaki operasyon ve operasyonların kontrolü için gerekli olan kullanıcı eforu düzeyi. [2]						
Kullanıcı Hatasından Korunma (User Error Protection): Uygulamanın kullanıcıyı hata yapmaktan koruma düzeyi.						
Kullanıcı Arayüzü Estetiği (User Interface Aesthetics): Uygulamanın tasarımsal ve işlevsel olarak çekiciliği.						
Erişilebilirlik (Accessibility): Uygulamanın erişilebilirlik seçenekleri. [2]						
Gizlilik(Confidentiality): Uygulama öğelerinin yetkisiz erişimden korunma düzeyi.						
Bütünlük(Integrity): Uygulamadaki değerlerin doğru ve tam olmasının korunma düzeyi.						
Sorumluluk(Accountability): Yapılan işlevlerin kimin tarafından yapıldığının takip edilme düzeyi.						
İspat Edilebilirlik(Authenticity): Uygulamada yapılan işlemin kime ait olduğunun ispat edilebilir olma düzeyi						
Birlikte Bulunma (Co-existence): Uygulamanın kendisinden bağımsız uygulamalarla aynı kaynakları kullanarak birlikte bulunma düzeyi. [2]						
Birlikte çalışabilirlik (Interoperability): Uygulamanın sistemle birlikte çalışabilir olma düzeyi. [2]						
Modülerlik (Modularity): Uygulama bileşenlerinden birinin üzerindeki değişiklik diğerlerinde minimum düzeydedir.						
Yeniden kullanılabilirlik (Reusability): Uygulamanın kısımlarının yeniden kullanılabilir olma düzeyi.						
Analiz edilebilirlik(Analyzability): Hataların yada eksikliklerin teşhis edilebilmesi için gerekli olan efor düzeyi. [2]						
Değişebilirlik(Modifiability): Hataya sebep olmadan etkin bir şekilde değiştirebilme düzeyi.						
Test edilebilirlik (Testability): Uygulamanın						

	1	2	3	4	5	6
test kriterlerine 103ke test edilebilirlik düzeyi. [2]						
Adapte edilebilirlik (Adaptability): Uygulamanın 103ke fo platformlara 103ke for olmadan adapte olabilme düzeyi. [2]						
Değiştirilebilirlik (Replaceability): Uygulama aynı ortamda aynı amaç için belirtilen başka bir uygulama yerine kullanılabilme düzeyi. [2]						
Kurulum Düzeyi(Installability): Uygulamanın kurulum kolaylık düzeyi. [2]						
Diğer (belirtiniz):						

12. "Diğer" için açıklama giriniz:

Lütfen yanıtınızı buraya yazınız:

(1) J. Garofalakis, A. Stefani, V. Stefanis & M. Xenos, 2007, "Quality Attributes of Consumer-Based M-Commerce Systems"

(2) B. Behkamal, M. Kahani & M. K. Akbari, 2009, "Customizing ISO 9126 quality model for evaluation of B2B applications"

APPENDIX B: GÖRÜŞME REHBERİ

Görüşmeyi Yapan:

Tarih & Saat:

Görüşme Süresi:

Merhaba,

Ben ODTÜ Bilişim Sistemleri Yüksek Lisans Öğrencisiyim. Öncelikle B2C Mobil Uygulamalarının Kalite Faktörleri ile ilgili yapmış olduğum bu araştırmaya görüşlerinizi bildirmeyi istediğiniz için çok teşekkür ediyorum.

B2C Mobil Uygulamaları kalitesi konusundaki kişisel tecrübeleriniz, fikir ve görüşleriniz bu araştırma için büyük önem taşımaktadır. Size B2C Mobil Uygulamaları özellikleri ve kalite faktörleri konusundaki görüşlerinizi almak için bazı sorular yönelteceğim.

Görüşmeye başlamadan önce, bir takım bilgi vermek istiyorum. Yapacağımız görüşme sadece araştırma amacıyla kullanılacaktır. Görüşmeden sonra, verilerin incelenmesi bir dizi süreçten geçecektir. Bu süreçte verinin doğru olduğunu anlamak adına görüşme bir çok defa dinlenecektir. Bundan dolayı görüşmenin sizin izninizle kayıt altına almak isterim. Buna ek olarak, görüşme esnasında belirtmiş olduğunuz görüşlerinizin ve fikirlerinizin 3. Şahıslarla paylaşılmayacağını ve gizli kalacağını belirtmek isterim.

Sizin sormak istediğiniz bir soru var mı?

Kişisel Bilgiler:

Adınız:	
Yaşınız:	
Mesleğiniz:	
E-Posta Adresiniz:	
Deneyim Süreniz:	
Mezun Olduğunuz Okul:	
Mezun Olduğunuz Bölüm:	

Görüşme Soruları:

B2C Mobil Uygulamaları Özellikleri

1. B2C Mobil Uygulamalarının en önemli özellikleri sizce nelerdir?

2. B2C Mobil Uygulamalarının hangi özellikleri sizin için olumlu düşünceler oluşturmaktadır? [1]

3. B2C Mobil Uygulamalarının hangi özellikleri sizin için olumsuz düşünceler oluşturmaktadır? [1] Olumsuz düşünceleri ortadan kaldırmak adına geliştirme için önerileriniz nelerdir?

B2C Mobil Uygulamaları Kalite Faktörleri

1. B2C Mobil Uygulamalarının kalitesi sizin için ne anlam ifade etmektedir? [1]

2. B2C Mobil Uygulamalarını değerlendirirken ne gibi kriterler kullanıyorsunuz? [1]

3. Mevcutta uygulama mağazasında bulunan yıldız kırılımının daha geniş başlıklar halinde olsa sizin için faydalı olur muydu?

4. Deneyiminize bağlı olarak, B2C mobil uygulamalarında kullanımını artıran faktörler hangileridir? [1] Kullanımı daha fazla artırmak adına geliştirme için önerileriniz nelerdir?

5. Deneyiminize bağlı olarak, B2C mobil uygulamalarında kullanımını azaltan faktörler hangileridir? [1] Kullanımı azaltan faktörleri azaltmak adına geliştirme için önerileriniz nelerdir?

6. B2C Mobil uygulamaları düşündüğünüzde, ISO25010 Kalite modeline gore sizce en önemli kalite faktörü hangisidir? (Fonsiyonel Uygunluk, Güvenirlilik, Performans Verimliliği, Güvenlik, Kullanılabilirlik, Uyumluluk, Sürdürülebilirlik, Taşınabilirlik)

7. B2C Mobil uygulamaları düşündüğünüzde, ISO25010 Kalite modeline gore sizce en önemsiz kalite faktörü hangisidir? (Fonsiyonel Uygunluk, Güvenirlilik, Performans Verimliliği, Güvenlik, Kullanılabilirlik, Uyumluluk, Sürdürülebilirlik, Taşınabilirlik)

(1) Alanezi, M.A., Kamil, A., and Basri S. (2010). A proposed intrument dimensions for measuring e-government service quality.

APPENDIX C: ANOVA DESCRIPTIVE RESULTS

Descriptives

Quality Characteristics or Factors	Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Product's Description	Mobile Developer	34	4.1765	.90355	.15496	3.8612	4.4917	1.00	5.00
	Software Developer	34	4.3529	.73371	.12583	4.0969	4.6089	3.00	5.00
	IT Expert	24	4.2917	.85867	.17528	3.9291	4.6543	2.00	5.00
	End-User	23	4.1304	.54808	.11428	3.8934	4.3674	3.00	5.00
	Total	115	4.2435	.77902	.07264	4.0996	4.3874	1.00	5.00
Use of Text	Mobile Developer	34	3.7353	.79043	.13556	3.4595	4.0111	2.00	5.00
	Software Developer	34	3.7353	.96323	.16519	3.3992	4.0714	2.00	6.00
	IT Expert	24	3.8333	.70196	.14329	3.5369	4.1297	3.00	5.00
	End-User	23	3.8261	.49103	.10239	3.6138	4.0384	3.00	5.00
	Total	115	3.7739	.77302	.07208	3.6311	3.9167	2.00	6.00
Use of Colors	Mobile Developer	34	4.1176	.76929	.13193	3.8492	4.3861	3.00	5.00
	Software Developer	34	3.7647	.92307	.15830	3.4426	4.0868	2.00	6.00

Descriptives									
Quality Characteristics or Factors	Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
	IT Expert	24	3.9583	.80645	.16462	3.6178	4.2989	3.00	5.00
	End-User	23	4.0000	.79772	.16634	3.6550	4.3450	3.00	5.00
	Total	115	3.9565	.83131	.07752	3.8030	4.1101	2.00	6.00
Use of Graphics	**Mobile Developer**	**34**	**4.4706**	**.66220**	**.11357**	**4.2395**	**4.7016**	**3.00**	**5.00**
	Software Developer	**34**	**3.9412**	**1.01328**	**.17378**	**3.5876**	**4.2947**	**2.00**	**6.00**
	IT Expert	**24**	**4.0000**	**.72232**	**.14744**	**3.6950**	**4.3050**	**3.00**	**5.00**
	End-User	**23**	**4.0000**	**.73855**	**.15400**	**3.6806**	**4.3194**	**3.00**	**5.00**
	Total	**115**	**4.1217**	**.82874**	**.07728**	**3.9686**	**4.2748**	**2.00**	**6.00**
Clarity	Mobile Developer	34	4.4118	.60891	.10443	4.1993	4.6242	3.00	6.00
	Software Developer	34	4.5000	.66287	.11368	4.2687	4.7313	3.00	6.00
	IT Expert	24	4.5833	.58359	.11913	4.3369	4.8298	3.00	5.00
	End-User	23	4.1739	.65033	.13560	3.8927	4.4551	3.00	5.00
	Total	115	4.4261	.63606	.05931	4.3086	4.5436	3.00	6.00
Appropriateness of Presentationı	**Mobile Developer**	**34**	**4.1765**	**.71650**	**.12288**	**3.9265**	**4.4265**	**3.00**	**6.00**
	Software	**34**	**4.6176**	**.60376**	**.10354**	**4.4070**	**4.8283**	**3.00**	**6.00**

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Developer								
	IT Expert	**24**	**4.2500**	**.89685**	**.18307**	**3.8713**	**4.6287**	**3.00**	**6.00**
	End-User	**23**	**4.0870**	**.84816**	**.17685**	**3.7202**	**4.4537**	**2.00**	**5.00**
	Total	**115**	**4.3043**	**.77430**	**.07220**	**4.1613**	**4.4474**	**2.00**	**6.00**
Navigation Mechanism	Mobile Developer	34	4.3235	.84282	.14454	4.0295	4.6176	2.00	5.00
	Software Developer	34	4.6471	.59708	.10240	4.4387	4.8554	3.00	5.00
	IT Expert	24	4.4583	.77903	.15902	4.1294	4.7873	2.00	6.00
	End-User	23	4.4348	.58977	.12298	4.1797	4.6898	3.00	5.00
	Total	115	4.4696	.71723	.06688	4.3371	4.6021	2.00	6.00
Access Keys	Mobile Developer	34	4.2647	.96323	.16519	3.9286	4.6008	2.00	6.00
	Software Developer	34	4.1765	.83378	.14299	3.8856	4.4674	2.00	5.00
	IT Expert	24	4.1667	.70196	.14329	3.8703	4.4631	3.00	5.00
	End-User	23	4.3478	.88465	.18446	3.9653	4.7304	1.00	5.00
	Total	115	4.2348	.85153	.07941	4.0775	4.3921	1.00	6.00
Use of Links	Mobile Developer	34	3.7941	1.03805	.17802	3.4319	4.1563	2.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Software Developer	34	3.8235	.83378	.14299	3.5326	4.1144	2.00	5.00
	IT Expert	24	3.8333	.81650	.16667	3.4886	4.1781	2.00	5.00
	End-User	23	4.1304	.91970	.19177	3.7327	4.5281	2.00	6.00
	Total	115	3.8783	.90948	.08481	3.7103	4.0463	2.00	6.00
Help	Mobile Developer	34	3.2647	.99419	.17050	2.9178	3.6116	1.00	5.00
	Software Developer	34	3.1471	.98880	.16958	2.8021	3.4921	2.00	5.00
	IT Expert	24	2.9167	1.17646	.24014	2.4199	3.4134	1.00	5.00
	End-User	23	3.1739	1.19286	.24873	2.6581	3.6897	1.00	5.00
	Total	115	3.1391	1.06694	.09949	2.9420	3.3362	1.00	5.00
Undo Functions	Mobile Developer	34	3.7941	.88006	.15093	3.4870	4.1012	2.00	6.00
	Software Developer	34	3.6471	1.17763	.20196	3.2362	4.0580	2.00	5.00
	IT Expert	24	4.1250	.99181	.20245	3.7062	4.5438	2.00	5.00
	End-User	23	3.7826	1.12640	.23487	3.2955	4.2697	2.00	5.00
	Total	115	3.8174	1.04783	.09771	3.6238	4.0110	2.00	6.00
User Oriented	Mobile	34	4.2353	.69887	.11985	3.9914	4.4791	3.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
Hierarchy	Developer								
	Software Developer	34	4.3235	.80606	.13824	4.0423	4.6048	2.00	5.00
	IT Expert	24	4.5000	.65938	.13460	4.2216	4.7784	3.00	5.00
	End-User	23	4.1304	.81488	.16991	3.7781	4.4828	2.00	5.00
	Total	115	4.2957	.74896	.06984	4.1573	4.4340	2.00	5.00
Security Mechanism	Mobile Developer	34	4.5882	.85697	.14697	4.2892	4.8872	1.00	5.00
	Software Developer	34	4.8235	.38695	.06636	4.6885	4.9585	4.00	5.00
	IT Expert	24	4.6250	.87539	.17869	4.2554	4.9946	1.00	5.00
	End-User	23	4.7391	.54082	.11277	4.5053	4.9730	3.00	5.00
	Total	115	4.6957	.69046	.06439	4.5681	4.8232	1.00	5.00
Pricing Mechanism	Mobile Developer	34	4.0588	.81431	.13965	3.7747	4.3429	2.00	5.00
	Software Developer	34	4.3235	.94454	.16199	3.9940	4.6531	0.00	5.00
	IT Expert	24	3.9167	.88055	.17974	3.5448	4.2885	2.00	5.00
	End-User	23	4.1739	.65033	.13560	3.8927	4.4551	3.00	5.00
	Total	115	4.1304	.84315	.07862	3.9747	4.2862	0.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
Alternative Payment Methods	Mobile Developer	34	3.7353	1.08177	.18552	3.3578	4.1127	1.00	5.00
	Software Developer	34	3.9412	.95159	.16320	3.6092	4.2732	2.00	5.00
	IT Expert	24	3.7500	.98907	.20189	3.3324	4.1676	2.00	5.00
	End-User	23	4.0870	.73318	.15288	3.7699	4.4040	2.00	5.00
	Total	115	3.8696	.95991	.08951	3.6922	4.0469	1.00	5.00
Authentication	Mobile Developer	34	4.0882	1.05508	.18094	3.7201	4.4564	1.00	5.00
	Software Developer	34	4.4412	.70458	.12083	4.1953	4.6870	3.00	5.00
	IT Expert	24	4.5833	.58359	.11913	4.3369	4.8298	3.00	5.00
	End-User	23	4.3478	.64728	.13497	4.0679	4.6277	3.00	5.00
	Total	115	4.3478	.80615	.07517	4.1989	4.4967	1.00	5.00
Personalization	Mobile Developer	34	3.4412	1.07847	.18496	3.0649	3.8175	1.00	5.00
	Software Developer	34	3.3529	1.06976	.18346	2.9797	3.7262	1.00	5.00
	IT Expert	24	3.4167	1.05981	.21633	2.9691	3.8642	1.00	5.00
	End-User	23	3.5217	.99405	.20727	3.0919	3.9516	2.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Total	115	3.4261	1.04345	.09730	3.2333	3.6188	1.00	5.00
Errors Tolerance	Mobile Developer	34	4.0000	1.25529	.21528	3.5620	4.4380	0.00	5.00
	Software Developer	34	3.9706	.93696	.16069	3.6437	4.2975	1.00	5.00
	IT Expert	24	4.0833	1.13890	.23248	3.6024	4.5643	0.00	5.00
	End-User	23	3.9130	.79275	.16530	3.5702	4.2559	3.00	5.00
	Total	115	3.9913	1.04710	.09764	3.7979	4.1847	0.00	5.00
Operation Response Time	Mobile Developer	34	4.2353	.74096	.12707	3.9768	4.4938	3.00	5.00
	Software Developer	34	4.2059	.76986	.13203	3.9373	4.4745	3.00	5.00
	IT Expert	24	4.3750	.71094	.14512	4.0748	4.6752	3.00	5.00
	End-User	23	4.1304	.81488	.16991	3.7781	4.4828	2.00	5.00
	Total	115	4.2348	.75313	.07023	4.0957	4.3739	2.00	5.00
Accuracy of the Operations	Mobile Developer	34	4.7353	.51102	.08764	4.5570	4.9136	3.00	5.00
	Software Developer	34	4.7353	.51102	.08764	4.5570	4.9136	3.00	5.00
	IT Expert	24	4.5417	.58823	.12007	4.2933	4.7901	3.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	End-User	23	4.4783	.66535	.13873	4.1905	4.7660	3.00	5.00
	Total	115	4.6435	.56493	.05268	4.5391	4.7478	3.00	5.00
Error Recovery	Mobile Developer	34	4.0882	1.02596	.17595	3.7303	4.4462	0.00	5.00
	Software Developer	34	4.2941	.75996	.13033	4.0290	4.5593	3.00	5.00
	IT Expert	24	4.0833	1.13890	.23248	3.6024	4.5643	0.00	5.00
	End-User	23	4.0870	.73318	.15288	3.7699	4.4040	3.00	5.00
	Total	115	4.1478	.91999	.08579	3.9779	4.3178	0.00	5.00
Shopping Chart - Metaphor	Mobile Developer	34	3.7059	1.08793	.18658	3.3263	4.0855	2.00	5.00
	Software Developer	34	4.0294	.99955	.17142	3.6807	4.3782	1.00	5.00
	IT Expert	24	4.0833	.77553	.15830	3.7559	4.4108	3.00	5.00
	End-User	23	3.8696	.81488	.16991	3.5172	4.2219	3.00	5.00
	Total	115	3.9130	.95113	.08869	3.7373	4.0887	1.00	5.00
Functional Suitability	**Mobile Developer**	**34**	**4.2941**	**.52394**	**.08985**	**4.1113**	**4.4769**	**3.00**	**5.00**
	Software Developer	**34**	**4.4412**	**.61255**	**.10505**	**4.2274**	**4.6549**	**3.00**	**5.00**

Descriptives									
Quality Characteristics or Factors	Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
	IT Expert	**24**	**4.4167**	**.58359**	**.11913**	**4.1702**	**4.6631**	**3.00**	**5.00**
	End-User	**23**	**3.9565**	**.92826**	**.19355**	**3.5551**	**4.3579**	**1.00**	**5.00**
	Total	**115**	**4.2957**	**.67504**	**.06295**	**4.1710**	**4.4204**	**1.00**	**5.00**
Reliability	Mobile Developer	34	4.6471	.54397	.09329	4.4573	4.8369	3.00	5.00
	Software Developer	34	4.6176	.60376	.10354	4.4070	4.8283	3.00	5.00
	IT Expert	24	4.6667	.48154	.09829	4.4633	4.8700	4.00	5.00
	End-User	23	4.6522	.48698	.10154	4.4416	4.8628	4.00	5.00
	Total	115	4.6435	.53297	.04970	4.5450	4.7419	3.00	5.00
Performance Efficiency	Mobile Developer	34	4.1765	.67288	.11540	3.9417	4.4112	3.00	5.00
	Software Developer	34	4.2941	.67552	.11585	4.0584	4.5298	3.00	5.00
	IT Expert	24	4.4167	.65386	.13347	4.1406	4.6928	3.00	5.00
	End-User	23	4.3913	.49901	.10405	4.1755	4.6071	4.00	5.00
	Total	115	4.3043	.63762	.05946	4.1866	4.4221	3.00	5.00
Usability	Mobile Developer	34	4.5000	.50752	.08704	4.3229	4.6771	4.00	5.00
	Software	34	4.3824	.69695	.11953	4.1392	4.6255	3.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Developer								
	IT Expert	24	4.3750	.64690	.13205	4.1018	4.6482	3.00	5.00
	End-User	23	4.5217	.66535	.13873	4.2340	4.8095	3.00	5.00
	Total	115	4.4435	.62396	.05818	4.3282	4.5587	3.00	5.00
Security	Mobile Developer	34	4.4706	.74814	.12831	4.2095	4.7316	3.00	5.00
	Software Developer	34	4.7059	.57889	.09928	4.5039	4.9079	3.00	5.00
	IT Expert	24	4.7500	.53161	.10851	4.5255	4.9745	3.00	5.00
	End-User	23	4.7826	.51843	.10810	4.5584	5.0068	3.00	5.00
	Total	115	4.6609	.61966	.05778	4.5464	4.7753	3.00	5.00
Compatibility	Mobile Developer	34	3.8235	.93649	.16061	3.4968	4.1503	2.00	5.00
	Software Developer	34	4.1765	.90355	.15496	3.8612	4.4917	2.00	5.00
	IT Expert	24	4.2083	.77903	.15902	3.8794	4.5373	3.00	6.00
	End-User	23	4.3043	.70290	.14657	4.0004	4.6083	3.00	6.00
	Total	115	4.1043	.86221	.08040	3.9451	4.2636	2.00	6.00
Portability	Mobile Developer	34	3.4706	1.02204	.17528	3.1140	3.8272	2.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Software Developer	34	3.7059	.93839	.16093	3.3785	4.0333	2.00	5.00
	IT Expert	24	3.9167	.65386	.13347	3.6406	4.1928	2.00	5.00
	End-User	23	3.9565	.82453	.17193	3.6000	4.3131	2.00	5.00
	Total	115	3.7304	.90148	.08406	3.5639	3.8970	2.00	6.00
Maintainability	Mobile Developer	34	4.1471	.82139	.14087	3.8605	4.4337	2.00	5.00
	Software Developer	34	4.1471	.95766	.16424	3.8129	4.4812	1.00	5.00
	IT Expert	24	4.5833	.58359	.11913	4.3369	4.8298	3.00	5.00
	End-User	23	4.1739	.71682	.14947	3.8639	4.4839	3.00	5.00
	Total	115	4.2435	.81209	.07573	4.0935	4.3935	1.00	5.00
Functional Appropriateness	Mobile Developer	34	4.2059	.72944	.12510	3.9514	4.4604	3.00	6.00
	Software Developer	34	4.2059	.80827	.13862	3.9239	4.4879	1.00	5.00
	IT Expert	24	4.3750	.57578	.11753	4.1319	4.6181	3.00	5.00
	End-User	23	4.2174	.73587	.15344	3.8992	4.5356	3.00	6.00
	Total	115	4.2435	.72052	.06719	4.1104	4.3766	1.00	6.00
Functional	Mobile	34	4.4706	.61473	.10543	4.2561	4.6851	3.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
Correctness	Developer								
	Software Developer	34	4.3824	.65202	.11182	4.1549	4.6099	3.00	5.00
	IT Expert	24	4.4583	.65801	.13431	4.1805	4.7362	3.00	6.00
	End-User	23	4.3043	.63495	.13240	4.0298	4.5789	3.00	5.00
	Total	115	4.4087	.63378	.05910	4.2916	4.5258	3.00	6.00
Functional Completeness	Mobile Developer	34	4.1176	.72883	.12499	3.8633	4.3719	3.00	6.00
	Software Developer	34	4.1765	.67288	.11540	3.9417	4.4112	3.00	5.00
	IT Expert	24	4.2917	.62409	.12739	4.0281	4.5552	3.00	5.00
	End-User	23	3.9130	.51461	.10730	3.6905	4.1356	3.00	5.00
	Total	115	4.1304	.65590	.06116	4.0093	4.2516	3.00	6.00
Maturity	Mobile Developer	34	4.2353	.74096	.12707	3.9768	4.4938	3.00	6.00
	Software Developer	34	4.0882	.79268	.13594	3.8117	4.3648	2.00	5.00
	IT Expert	24	4.4167	.82970	.16936	4.0663	4.7670	2.00	5.00
	End-User	23	4.2609	.54082	.11277	4.0270	4.4947	3.00	5.00
	Total	115	4.2348	.74139	.06913	4.0978	4.3717	2.00	6.00

Descriptives									
Quality Characteristics or Factors	Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Availability	Mobile Developer	34	4.2353	.78079	.13390	3.9629	4.5077	3.00	6.00
	Software Developer	34	4.3529	.73371	.12583	4.0969	4.6089	3.00	5.00
	IT Expert	24	4.5000	.58977	.12039	4.2510	4.7490	3.00	5.00
	End-User	23	4.4348	.66237	.13811	4.1484	4.7212	3.00	5.00
	Total	115	4.3652	.70500	.06574	4.2350	4.4955	3.00	6.00
Fault Tolerance	Mobile Developer	34	4.2353	.78079	.13390	3.9629	4.5077	3.00	5.00
	Software Developer	34	4.2353	.78079	.13390	3.9629	4.5077	2.00	5.00
	IT Expert	24	4.4583	.58823	.12007	4.2099	4.7067	3.00	5.00
	End-User	23	4.0435	.82453	.17193	3.6869	4.4000	3.00	6.00
	Total	115	4.2435	.75616	.07051	4.1038	4.3832	2.00	6.00
Recoverability	Mobile Developer	34	4.3824	.81704	.14012	4.0973	4.6674	2.00	6.00
	Software Developer	34	4.4118	.74336	.12749	4.1524	4.6711	3.00	5.00
	IT Expert	24	4.3750	.71094	.14512	4.0748	4.6752	3.00	5.00
	End-User	23	4.4348	.84348	.17588	4.0700	4.7995	2.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Total	115	4.4000	.77005	.07181	4.2577	4.5423	2.00	6.00
Time Behaviour	Mobile Developer	34	4.1471	.89213	.15300	3.8358	4.4583	2.00	5.00
	Software Developer	34	4.0882	.66822	.11460	3.8551	4.3214	3.00	5.00
	IT Expert	24	4.3750	.57578	.11753	4.1319	4.6181	3.00	5.00
	End-User	23	4.1739	.49103	.10239	3.9616	4.3862	3.00	5.00
	Total	115	4.1826	.69563	.06487	4.0541	4.3111	2.00	5.00
Resource Utilization	Mobile Developer	34	3.8235	.96830	.16606	3.4857	4.1614	2.00	6.00
	Software Developer	34	4.0000	.81650	.14003	3.7151	4.2849	2.00	5.00
	IT Expert	24	3.7917	.50898	.10389	3.5767	4.0066	3.00	5.00
	End-User	23	3.9130	.73318	.15288	3.5960	4.2301	2.00	5.00
	Total	115	3.8870	.79212	.07387	3.7406	4.0333	2.00	6.00
Capacity	Mobile Developer	34	3.8529	.92548	.15872	3.5300	4.1759	2.00	6.00
	Software Developer	34	3.8824	.87956	.15084	3.5755	4.1892	2.00	5.00
	IT Expert	24	3.8750	.89988	.18369	3.4950	4.2550	2.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	End-User	23	4.2174	.73587	.15344	3.8992	4.5356	3.00	6.00
	Total	115	3.9391	.87145	.08126	3.7781	4.1001	2.00	6.00
Appropriateness Recognisability	Mobile Developer	34	3.7059	.79884	.13700	3.4272	3.9846	2.00	5.00
	Software Developer	34	4.0294	1.02942	.17654	3.6702	4.3886	2.00	6.00
	IT Expert	24	3.9583	.75060	.15322	3.6414	4.2753	3.00	6.00
	End-User	23	3.8261	.88688	.18493	3.4426	4.2096	2.00	6.00
	Total	115	3.8783	.88007	.08207	3.7157	4.0408	2.00	6.00
Learnability	Mobile Developer	34	3.9706	.93696	.16069	3.6437	4.2975	2.00	5.00
	Software Developer	34	4.0588	.98292	.16857	3.7159	4.4018	1.00	5.00
	IT Expert	24	4.0417	.80645	.16462	3.7011	4.3822	2.00	5.00
	End-User	23	3.9130	.66831	.13935	3.6240	4.2020	3.00	5.00
	Total	115	4.0000	.86855	.08099	3.8396	4.1604	1.00	5.00
Operability	Mobile Developer	34	3.9706	.86988	.14918	3.6671	4.2741	3.00	6.00
	Software Developer	34	4.0000	.88763	.15223	3.6903	4.3097	2.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	IT Expert	24	4.0833	.88055	.17974	3.7115	4.4552	2.00	6.00
	End-User	23	3.8261	.57621	.12015	3.5769	4.0753	3.00	5.00
	Total	115	3.9739	.82143	.07660	3.8222	4.1257	2.00	6.00
User Error Protection	Mobile Developer	34	4.1176	.84440	.14481	3.8230	4.4123	2.00	5.00
	Software Developer	34	4.1471	.82139	.14087	3.8605	4.4337	2.00	5.00
	IT Expert	24	4.3750	.64690	.13205	4.1018	4.6482	3.00	5.00
	End-User	23	4.0870	.79275	.16530	3.7441	4.4298	3.00	5.00
	Total	115	4.1739	.78652	.07334	4.0286	4.3192	2.00	5.00
User Interface Aesthetics	Mobile Developer	34	4.3529	.59708	.10240	4.1446	4.5613	3.00	5.00
	Software Developer	34	4.0294	.83431	.14308	3.7383	4.3205	2.00	5.00
	IT Expert	24	4.2083	.58823	.12007	3.9599	4.4567	3.00	5.00
	End-User	23	4.0870	.59643	.12436	3.8290	4.3449	3.00	5.00
	Total	115	4.1739	.67876	.06329	4.0485	4.2993	2.00	5.00
Accessibility	Mobile Developer	34	3.8529	.92548	.15872	3.5300	4.1759	2.00	6.00
	Software	34	3.9706	.90404	.15504	3.6552	4.2860	2.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Developer								
	IT Expert	24	4.2083	.72106	.14719	3.9039	4.5128	3.00	5.00
	End-User	23	3.9565	.97600	.20351	3.5345	4.3786	2.00	6.00
	Total	115	3.9826	.88835	.08284	3.8185	4.1467	2.00	6.00
Confidentiality	Mobile Developer	34	4.1176	.87956	.15084	3.8108	4.4245	2.00	5.00
	Software Developer	34	4.5588	.66017	.11322	4.3285	4.7892	3.00	5.00
	IT Expert	24	4.4167	.58359	.11913	4.1702	4.6631	3.00	5.00
	End-User	23	4.5217	.73048	.15232	4.2059	4.8376	2.00	5.00
	Total	115	4.3913	.74570	.06954	4.2536	4.5291	2.00	5.00
Integrity	**Mobile Developer**	**34**	**4.0588**	**.77621**	**.13312**	**3.7880**	**4.3297**	**3.00**	**6.00**
	Software Developer	**34**	**4.2941**	**.62906**	**.10788**	**4.0746**	**4.5136**	**3.00**	**5.00**
	IT Expert	**24**	**4.5417**	**.50898**	**.10389**	**4.3267**	**4.7566**	**4.00**	**5.00**
	End-User	**23**	**3.9565**	**.56232**	**.11725**	**3.7134**	**4.1997**	**3.00**	**5.00**
	Total	**115**	**4.2087**	**.66880**	**.06237**	**4.0851**	**4.3322**	**3.00**	**6.00**
Accountability	Mobile Developer	34	3.8824	.97746	.16763	3.5413	4.2234	2.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Software Developer	34	4.1176	.91336	.15664	3.7990	4.4363	2.00	5.00
	IT Expert	24	4.2500	.79400	.16207	3.9147	4.5853	2.00	5.00
	End-User	23	4.2609	.75181	.15676	3.9358	4.5860	3.00	5.00
	Total	115	4.1043	.88232	.08228	3.9414	4.2673	2.00	5.00
Authencity	Mobile Developer	34	3.9706	.93696	.16069	3.6437	4.2975	2.00	5.00
	Software Developer	34	4.3235	.80606	.13824	4.0423	4.6048	2.00	6.00
	IT Expert	24	4.3333	.91683	.18715	3.9462	4.7205	2.00	5.00
	End-User	23	4.2174	.95139	.19838	3.8060	4.6288	2.00	6.00
	Total	115	4.2000	.90029	.08395	4.0337	4.3663	2.00	6.00
Co-existence	Mobile Developer	34	3.5294	1.21194	.20785	3.1065	3.9523	1.00	6.00
	Software Developer	34	3.6176	.88813	.15231	3.3078	3.9275	2.00	5.00
	IT Expert	24	3.7917	.93153	.19015	3.3983	4.1850	2.00	6.00
	End-User	23	3.7826	.90235	.18815	3.3924	4.1728	2.00	6.00
	Total	115	3.6609	.99901	.09316	3.4763	3.8454	1.00	6.00
Interoperability	Mobile	34	3.8235	1.02899	.17647	3.4645	4.1826	2.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Developer								
	Software Developer	34	3.8824	.87956	.15084	3.5755	4.1892	2.00	5.00
	IT Expert	24	3.9583	.90790	.18532	3.5750	4.3417	2.00	6.00
	End-User	23	3.9130	.79275	.16530	3.5702	4.2559	2.00	6.00
	Total	115	3.8870	.90578	.08446	3.7196	4.0543	2.00	6.00
Modularity	Mobile Developer	34	3.8529	1.13170	.19409	3.4581	4.2478	1.00	6.00
	Software Developer	34	3.9412	.77621	.13312	3.6703	4.2120	2.00	5.00
	IT Expert	24	4.0833	.82970	.16936	3.7330	4.4337	2.00	6.00
	End-User	23	3.9565	.97600	.20351	3.5345	4.3786	3.00	6.00
	Total	115	3.9478	.93512	.08720	3.7751	4.1206	1.00	6.00
Reusability	Mobile Developer	34	3.8529	.85749	.14706	3.5537	4.1521	2.00	5.00
	Software Developer	34	3.7941	.80827	.13862	3.5121	4.0761	2.00	5.00
	IT Expert	24	4.0000	.58977	.12039	3.7510	4.2490	3.00	5.00
	End-User	23	3.6087	.98807	.20603	3.1814	4.0360	1.00	6.00
	Total	115	3.8174	.82273	.07672	3.6654	3.9694	1.00	6.00

Descriptives									
Quality Characteristics or Factors	Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Analyzability	Mobile Developer	34	3.9118	.83003	.14235	3.6222	4.2014	2.00	5.00
	Software Developer	34	4.0000	.81650	.14003	3.7151	4.2849	2.00	5.00
	IT Expert	24	3.9583	.69025	.14090	3.6669	4.2498	3.00	5.00
	End-User	23	4.0000	.85280	.17782	3.6312	4.3688	2.00	6.00
	Total	115	3.9652	.79395	.07404	3.8186	4.1119	2.00	6.00
Modifiability	Mobile Developer	34	4.1176	.91336	.15664	3.7990	4.4363	2.00	6.00
	Software Developer	34	4.1471	.82139	.14087	3.8605	4.4337	2.00	5.00
	IT Expert	24	4.1250	.61237	.12500	3.8664	4.3836	3.00	5.00
	End-User	23	3.7826	.95139	.19838	3.3712	4.1940	2.00	6.00
	Total	115	4.0609	.84071	.07840	3.9056	4.2162	2.00	6.00
Testability	Mobile Developer	34	3.9706	.75820	.13003	3.7060	4.2351	2.00	5.00
	Software Developer	34	4.0882	.86577	.14848	3.7862	4.3903	2.00	5.00
	IT Expert	24	4.1667	.76139	.15542	3.8452	4.4882	2.00	5.00
	End-User	23	3.8696	1.05763	.22053	3.4122	4.3269	1.00	6.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	Total	115	4.0261	.85287	.07953	3.8685	4.1836	1.00	6.00
Adaptability	Mobile Developer	34	3.4118	1.10420	.18937	3.0265	3.7970	1.00	5.00
	Software Developer	34	3.8824	1.00799	.17287	3.5306	4.2341	2.00	5.00
	IT Expert	24	4.0000	.65938	.13460	3.7216	4.2784	3.00	5.00
	End-User	23	3.7826	.99802	.20810	3.3510	4.2142	2.00	6.00
	Total	115	3.7478	.98980	.09230	3.5650	3.9307	1.00	6.00
Replaceability	Mobile Developer	34	3.5882	1.04787	.17971	3.2226	3.9539	1.00	5.00
	Software Developer	34	3.7941	1.14890	.19703	3.3932	4.1950	1.00	6.00
	IT Expert	24	3.7917	.97709	.19945	3.3791	4.2043	1.00	5.00
	End-User	23	3.7391	1.13688	.23706	3.2475	4.2308	1.00	6.00
	Total	115	3.7217	1.07236	.10000	3.5236	3.9198	1.00	6.00
Installability	Mobile Developer	34	3.5294	1.02204	.17528	3.1728	3.8860	1.00	5.00
	Software Developer	34	3.9118	1.02596	.17595	3.5538	4.2697	2.00	6.00
	IT Expert	24	4.0417	.75060	.15322	3.7247	4.3586	3.00	5.00

Descriptives									
Quality Characteristics or Factors	**Groups**	**N**	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
						Lower Bound	**Upper Bound**		
	End-User	23	4.0435	1.02151	.21300	3.6017	4.4852	1.00	6.00
	Total	115	3.8522	.98447	.09180	3.6703	4.0340	1.00	6.00

APPENDIX D: ANOVA

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
Product's Description	Between Groups	.910	3	.303	.493	.688
	Within Groups	68.273	111	.615		
	Total	69.183	114			
Use of Text	Between Groups	.249	3	.083	.136	.939
	Within Groups	67.873	111	.611		
	Total	68.122	114			
Use of Colors	Between Groups	2.177	3	.726	1.052	.373
	Within Groups	76.605	111	.690		
	Total	78.783	114			
Use of Graphics	**Between Groups**	**5.943**	**3**	**1.981**	**3.039**	**.032**
	Within Groups	**72.353**	**111**	**.652**		
	Total	**78.296**	**114**			
Clarity	Between Groups	2.249	3	.750	1.896	.134
	Within Groups	43.873	111	.395		
	Total	46.122	114			
Appropriateness of Presentation	**Between Groups**	**5.051**	**3**	**1.684**	**2.953**	**.036**
	Within Groups	**63.297**	**111**	**.570**		
	Total	**68.348**	**114**			
Navigation Mechanism	Between Groups	1.827	3	.609	1.190	.317
	Within Groups	56.816	111	.512		
	Total	58.643	114			
Access Keys	Between Groups	.551	3	.184	.248	.862
	Within Groups	82.110	111	.740		
	Total	82.661	114			
Use of Links	Between Groups	1.854	3	.618	.742	.529

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
	Within Groups	92.442	111	.833		
	Total	94.296	114			
Help	Between Groups	1.754	3	.585	.507	.678
	Within Groups	128.020	111	1.153		
	Total	129.774	114			
Undo Functions	Between Groups	3.304	3	1.101	1.003	.394
	Within Groups	121.862	111	1.098		
	Total	125.165	114			
User Oriented Hierarchy	Between Groups	1.780	3	.593	1.060	.369
	Within Groups	62.168	111	.560		
	Total	63.948	114			
Security Mechanism	Between Groups	1.112	3	.371	.773	.512
	Within Groups	53.236	111	.480		
	Total	54.348	114			
Pricing Mechanism	Between Groups	2.582	3	.861	1.218	.307
	Within Groups	78.461	111	.707		
	Total	81.043	114			
Alternative Payment Methods	Between Groups	2.217	3	.739	.798	.498
	Within Groups	102.826	111	.926		
	Total	105.043	114			
Authentication	Between Groups	3.919	3	1.306	2.066	.109
	Within Groups	70.168	111	.632		
	Total	74.087	114			
Personalization	Between Groups	.402	3	.134	.120	.948
	Within Groups	123.720	111	1.115		
	Total	124.122	114			
Errors Tolerance	Between Groups	.361	3	.120	.107	.956
	Within Groups	124.630	111	1.123		

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
	Total	124.991	114			
Operation Response Time	Between Groups	.751	3	.250	.435	.729
	Within Groups	63.910	111	.576		
	Total	64.661	114			
Accuracy of the Operations	Between Groups	1.450	3	.483	1.536	.209
	Within Groups	34.933	111	.315		
	Total	36.383	114			
Error Recovery	Between Groups	1.033	3	.344	.401	.753
	Within Groups	95.454	111	.860		
	Total	96.487	114			
Shopping Chart - Metaphor	Between Groups	2.659	3	.886	.979	.405
	Within Groups	100.471	111	.905		
	Total	103.130	114			
Functional Suitability	**Between Groups**	**3.717**	**3**	**1.239**	**2.851**	**.041**
	Within Groups	**48.231**	**111**	**.435**		
	Total	**51.948**	**114**			
Reliability	Between Groups	.038	3	.013	.043	.988
	Within Groups	32.345	111	.291		
	Total	32.383	114			
Performance Efficiency	Between Groups	1.036	3	.345	.846	.471
	Within Groups	45.312	111	.408		
	Total	46.348	114			
Usability	Between Groups	.489	3	.163	.412	.745
	Within Groups	43.894	111	.395		
	Total	44.383	114			
Security	Between Groups	1.831	3	.610	1.616	.190
	Within Groups	41.942	111	.378		

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
	Total	43.774	114			
Compatibility	Between Groups	4.038	3	1.346	1.851	.142
	Within Groups	80.710	111	.727		
	Total	84.748	114			
Portability	Between Groups	4.324	3	1.441	1.812	.149
	Within Groups	88.319	111	.796		
	Total	92.643	114			
Maintainability	Between Groups	3.516	3	1.172	1.815	.149
	Within Groups	71.667	111	.646		
	Total	75.183	114			
Functional Appropriateness	Between Groups	.527	3	.176	.332	.802
	Within Groups	58.656	111	.528		
	Total	59.183	114			
Functional Correctness	Between Groups	.463	3	.154	.378	.769
	Within Groups	45.328	111	.408		
	Total	45.791	114			
Functional Completeness	Between Groups	1.788	3	.596	1.400	.247
	Within Groups	47.255	111	.426		
	Total	49.043	114			
Maturity	Between Groups	1.540	3	.513	.932	.428
	Within Groups	61.121	111	.551		
	Total	62.661	114			
Availability	Between Groups	1.126	3	.375	.750	.524
	Within Groups	55.535	111	.500		
	Total	56.661	114			
Fault Tolerance	Between Groups	2.032	3	.677	1.191	.317
	Within Groups	63.150	111	.569		
	Total	65.183	114			

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
Recoverability	Between Groups	.058	3	.019	.032	.992
	Within Groups	67.542	111	.608		
	Total	67.600	114			
Time Behaviour	Between Groups	1.236	3	.412	.848	.471
	Within Groups	53.929	111	.486		
	Total	55.165	114			
Resource Utilization	Between Groups	.805	3	.268	.421	.738
	Within Groups	70.726	111	.637		
	Total	71.530	114			
Capacity	Between Groups	2.242	3	.747	.984	.403
	Within Groups	84.332	111	.760		
	Total	86.574	114			
Appropriateness Recognisability	Between Groups	2.004	3	.668	.859	.465
	Within Groups	86.292	111	.777		
	Total	88.296	114			
Learnability	Between Groups	.363	3	.121	.157	.925
	Within Groups	85.637	111	.772		
	Total	86.000	114			
Operability	Between Groups	.813	3	.271	.395	.757
	Within Groups	76.108	111	.686		
	Total	76.922	114			
User Error Protection	Between Groups	1.277	3	.426	.682	.565
	Within Groups	69.245	111	.624		
	Total	70.522	114			
User Interface Aesthetics	Between Groups	2.002	3	.667	1.466	.228
	Within Groups	50.520	111	.455		
	Total	52.522	114			
Accessibility	Between	1.815	3	.605	.762	.518

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
	Groups					
	Within Groups	88.150	111	.794		
	Total	89.965	114			
Confidentiality	Between Groups	3.907	3	1.302	2.430	.069
	Within Groups	59.484	111	.536		
	Total	63.391	114			
Integrity	**Between Groups**	**5.135**	**3**	**1.712**	**4.144**	**.008**
	Within Groups	**45.856**	**111**	**.413**		
	Total	**50.991**	**114**			
Accountability	Between Groups	2.754	3	.918	1.185	.319
	Within Groups	85.994	111	.775		
	Total	88.748	114			
Authencity	Between Groups	2.742	3	.914	1.132	.340
	Within Groups	89.658	111	.808		
	Total	92.400	114			
Co-existence	Between Groups	1.403	3	.468	.462	.710
	Within Groups	112.371	111	1.012		
	Total	113.774	114			
Interoperability	Between Groups	.275	3	.092	.109	.955
	Within Groups	93.255	111	.840		
	Total	93.530	114			
Modularity	Between Groups	.750	3	.250	.280	.839
	Within Groups	98.937	111	.891		
	Total	99.687	114			
Reusability	Between Groups	1.863	3	.621	.916	.436
	Within Groups	75.302	111	.678		
	Total	77.165	114			
Analyzability	Between	.167	3	.056	.086	.967

Quality Characteristics or Factors		Sum of Squares	df	Mean Square	F	Sig.
	Groups					
	Within Groups	71.694	111	.646		
	Total	71.861	114			
Modifiability	Between Groups	2.242	3	.747	1.059	.370
	Within Groups	78.332	111	.706		
	Total	80.574	114			
Testability	Between Groups	1.274	3	.425	.577	.631
	Within Groups	81.648	111	.736		
	Total	82.922	114			
Adaptability	Between Groups	6.009	3	2.003	2.104	.104
	Within Groups	105.678	111	.952		
	Total	111.687	114			
Replaceability	Between Groups	.908	3	.303	.258	.855
	Within Groups	130.187	111	1.173		
	Total	131.096	114			
Installability	Between Groups	5.366	3	1.789	1.889	.136
	Within Groups	105.121	111	.947		
	Total	110.487	114			

APPENDIX E: TEST OF HOMOGENEITY OF VARIANCES

Quality Characteristics or Factors	Levene Statistic	df1	df2	Sig.
Product's Description	2.680	3	111	.050
Use of Text	3.117	3	111	.029
Use of Colors	.536	3	111	.659
Use of Graphics	**2.072**	**3**	**111**	**.108**
Clarity	.449	3	111	.718
Appropriateness of Presentationı	**1.831**	**3**	**111**	**.146**
Navigation Mechanism	2.262	3	111	.085
Access Keys	1.333	3	111	.267
Use of Links	1.366	3	111	.257
Help	.527	3	111	.665
Undo Functions	2.892	3	111	.039
User Oriented Hierarchy	.374	3	111	.772
Security Mechanism	2.805	3	111	.043
Pricing Mechanism	.281	3	111	.839
Alternative Payment Methods	2.771	3	111	.045
Authentication	1.358	3	111	.259
Personalization	.054	3	111	.983
Errors Tolerance	.350	3	111	.789
Operation Response Time	.071	3	111	.976
Accuracy of the Operations	2.981	3	111	.034
Error Recovery	.464	3	111	.708
Shopping Chart - Metaphor	1.962	3	111	.124
Functional Suitability	**.693**	**3**	**111**	**.558**
Reliability	.572	3	111	.634
Performance Efficiency	.663	3	111	.577
Usability	1.349	3	111	.262
Security	4.200	3	111	.007
Comptability	1.055	3	111	.371
Portability	4.592	3	111	.005
Maintainability	.666	3	111	.575
Functional Appropriateness	.066	3	111	.978
Functional Correctness	.114	3	111	.952
Functional Completeness	1.608	3	111	.192
Maturity	1.120	3	111	.344

Quality Characteristics or Factors	Levene Statistic	df1	df2	Sig.
Availability	.448	3	111	.720
Fault Tolerance	.533	3	111	.661
Recoverability	.122	3	111	.947
Time Behaviour	3.296	3	111	.023
Resource Utilization	2.436	3	111	.068
Capacity	.271	3	111	.846
Appropriateness Recognisability	1.579	3	111	.198
Learnability	1.895	3	111	.135
Operability	1.113	3	111	.347
User Error Protection	.258	3	111	.855
User Interface Aesthetics	1.644	3	111	.183
Accessibility	.443	3	111	.723
Confidentiality	1.565	3	111	.202
Integrity	**1.759**	**3**	**111**	**.159**
Accountability	.414	3	111	.743
Authencity	.511	3	111	.675
Co-existence	2.700	3	111	.049
Interoperability	1.489	3	111	.221
Modularity	1.692	3	111	.173
Reusability	2.969	3	111	.035
Analyzability	.518	3	111	.671
Modifiability	1.377	3	111	.254
Testability	.880	3	111	.454
Adaptability	3.593	3	111	.016
Replaceability	.654	3	111	.582
Installability	1.428	3	111	.238

APPENDIX F: PARTICIPANTS' OPINIONS (IN TURKISH)

Participants' answers in semi-structured interview which validates the quantitative results for RQ1 are given below;

Two interviewees stated the importance of presentation dimension as:

"Kullanım deneyimi anlamında, kullanılan grafiklerin düzgün seçilmiş olması, temiz bir arayüzünün olması, çok karmaşık olmaması gereklidir" (Interviewee 9, SD / Opinion1.1)

"Ticari bir faaliyet olduğu için kullanıcıya bir şey sunduğumuzda uygulamanın yine web sitelerinde olduğu gibi görsellik açısından da tasarım açısından da kullanıcıya bir caziplik vermemiz gerekiyor" (Interviewee 3, MD / Opinion1.2)

Two of the interview participants mentioned the importance of navigation mechanism by stating that:

"Navigasyonunun kolay olması, daha sonra daldan dala atlamayan bir mekanizmaya sahip olması çok önemli. Navigasyon çok iyi belirlenmeli, çünkü mobilde kısıtlı bir ortamda çalışılıyor. Webteki herşey yapılamadığı için navigasyon üzerinde çok çalışılması gerekiyor" (Interviewee 9, SD / Opinion1.3)

"Navigasyon çok önemli. Bazı uygulamalar görüyoruz; tıklıyoruz başka şeylere gidiyor. Aradığımız butonları bulamıyoruz, anasayfa olsun, ayarlar olsun" (Interviewee 4, ITE / Opinion1.4)

Most of the interview participants mentioned the importance of security mechanism in the purchasing dimension. Some of the interviewers' opinions are given below:

"Güvenlik daha önemli tabi bir şekilde sizi ben güvenliyim diye ikna etmesi lazım. Ödeme sistemlerinden, check out ettiğin ürünün sana rezerve edilmesine kadar bunlarında çok üzerine düşülmesi gerekiyor" (Interviewee 9, SD / Opinion1.5)

"Bir mobil ticaret uygulamasında ticaret kısmı olduğu için öncelikle bir satınalma, alışveriş, bankalar işin işin içine giriyor, kredi kartı işin içine giriyor. O yüzden kullanıcıyı daha rahat düşündürebilmek için, kullanıcıya güvenlik açısından iyi şeyler hissettirebilmemiz gerekiyor. Bizim güvenlik açığımız yok dememiz gerekiyor. Özellikle Türkiyedeki kullanıcılar herhangi bir satın alma işleminde herhangi bir kredi kartı bilgilerini vermeden önce güvenliğini daha çok ön plana çıkartıyor." (Interviewee 3, MD / Opinion1.6)

"Benim için privacy önemli. Benim ilk aklıma gelen güvenlik. Benim kişisel bilgilerimin nasıl kullanıldığı uygulamalar tarafından beni tedirgin ediyor. Bir uygulamayı yüklerken önce açıklamalarını okuyup kişisel verilerle ilgili ne tür bilgiler topladıklarına dikkat ederim." (Interviewee 6, ITE / Opinion1.7)

"En önemli özellik başta güvenliktir, kredi kartını verdiğin için. İkincisi alacağın ürünü ne kadar tanıttığı görsellik olarak." (Interviewee 8, EU / Opinion1.8)

Participants' answers in semi-structured interview which validates the quantitative results for RQ2 are given below;

"Uygulamada para hareketi olacaksa güvenilirliği önemlidir. Para transaction işleminin güvenilir bir şekilde yapıldığı, kredi kartı bilgimi verdiğim zaman başkasının eline geçmemesi önemli faktörlerdir. Bu noktada once güvenlik daha sonar güvenilirlik gelir. Bunlara ek olarak kullanım kolaylığı, navigasyonu ve tasarımı da önemlidir."(Interviewee 10, SD/ Opinion2.1).

"İlk başta güvenlik gelir. Güvenlikten sonra uygulamanın kullanılabilirliği ikinci sırada geliyor. Yani telefonun ekranı çok büyük olmadığı için parmaklarla rahat kullanılabilir mi değil mi bu çok önemli benim için, navigasyon açısından rahatlıkla kullanabiliyormuyum önemlidir" (Interviewee 6, ITE / Opinion2.2).

"Fonksiyonalitesi, güvenliği, kullanılabilirliği iyi olmalıdır. Sonuçta ticari bir uygulamaysa bir takım bilgileri girmek gerekiyor. Kredi kartı bilgilerinin girişinde kolaylık sağlaması lazım." (Interviewee 7, EU / Opinion2.3).

"En başta hız, stabil olması ve çalışması. User friendly, kullanıcılara kullanım zorluğu çektirmeyecek olması. Örneğin, buton sağa kaymıştır, görünmeyen bir noktadadır. Sepete at başka bir yerdedir.Sil başka yerdedir." (Interviewee 5, / Opinion2.4).

"Kullanıcılar 3G'nin çok az çektiği yerlerde uygulama çalışmıyor veya hata veriyor gibi yorumlarda bulunuyor. Geliştirme esnasında dikkate alınması gerekiyor bunun. Bazı uygulamadaki fonksiyonları asenkron bir şekilde çalıştırmak gerekebilir. Ya da bazı fonksiyonların gerçekleştirilebilmesi için kullanıcıya hızlı bir internetin gerekli olduğu bilgisi verilebilir" (Interviewee 3, MD / Opinion2.5).

To understand the most important quality factors by ordering, semi-structured interview question 9 was asked.

One of the interviewees mentioned the importance of usability by stating that:

"Mobilde en büyük sıkıntı ekran küçük olduğu için, bilgi girişlerinde kolaylık sağlanmalıdır. Benim gibi tombul parmakları olanlar bilgi girişinde zorluk yaşıyor. Bilgi girişini ne kadar kolaylaştırırsan kullanım kolaylığı o kadar rahatlar. Örneğin; apple'ın sanal klavyesinde ilk ekranda @ işareti çıkıyor. Mail adresimi gireceğim zaman bu benim işimi baya kolaylaştırıyor." (Interviewee 7, EU / Opinion2.6).

Another interviewee mentioned the importance of security by stating that:

"Mobilde biraz daha güvensiz ve kontrolümüz dışında olan bir ortam var. Uygulamaların bizden ne aldığını bilmediğimiz için telefon rehberini boşaltma, resimlere ulaşma vs." (Interviewee 6, ITE / Opinion2.7).

To understand the least important quality factor by interviewee's order, semi-structured interview question 10 was conducted.

One of the interviewees who is mobile developer stated that:

"Taşınabilirlik kullanıcı açısından çok da önemli değil, ayrı ayrı teknolojiler kullandıkları platformlar farklı." (Interviewee 3, MD / Opinion2.8).

One of the interviewees verified the mobile developer opinion by stating that:

"Sadece apple uygulaması kullandığım için taşınabilirlik benim için çok önemli bir şey değil" (Interviewee 7, EU / Opinion2.9).

Participants' responses for the importance degree of B2C mobile quality sub-factors in the semi-structured interview are given below;

One of the interviewees who is an IT Expert mentioned the availability of the application is important by stating that:

"Mobilde, internette yaptığımız alışveriş sitelerini düşündüğümüz gibi her zaman 7/24 ulaşılabilir olmalı ve devamlı çalışabilmelidir. Yani belli süreler arasında gitmesini istemem. Bazı uygulamalarda, bazı dilimlerde aşırı kilitlenme yaşıyor ve istediğim işlemi gerçekleştiremiyorum" (Interviewee 6, ITE / Opinion2.10)

One of the interviewees who is a software developer mentioned the learnability of the application is important by stating that:

"Hiç bir desteğe ihtiyaç duymadan, help dokümanı kullanmadan uygulamayı kullanabilmeliyim" (Interviewee 10, SD / Opinion2.11).

One of the interviewees who is an IT Expert mentioned the functional appropriateness and time behavior of the application are important by stating that:

"Bence işlevsellik, amaca hizmet etmesi. Örneğin bir banka uygulamasından bahsedeyim, EFT yapmak istiyorsam, hızlıca yapabilmeliyim." (Interviewee 4, ITE / Opinion2.12).

Participants' answers in semi-structured interview for RQ6 are given below;

"5 yıldız dışında bir şey yok. Türkiye'de de düşük puan verince en yukarıda gösteriyor. Yani artık yıldızlarında bir hükmü kalmadı. Ama böyle detaylı şekilde görebilsek çok iyi olur" (Interviewee 4, ITE / Opinion6.1).

"Daha yararlı olur, ilk bakacağım yer olur. Bir uygulama için çok zaman harcayabiliyorum. Beni o zaman harcamasından kurtarır" (Interviewee 6, ITE / Opinion6.2).

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YAZARIN

Soyadı : .....
Adı : .....
Bölümü : .....

TEZİN ADI (İngilizce) : .....
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TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

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