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Mobile Computing Trends in Saudi Arabia: An Exploratory Study

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***Abstract*—**The main purpose of this research was to gain an understanding of the adoption behavior of mobile computing in Saudi Arabia. In particular, it aimed to acquire new insight into mobile computing trends, specifically in Saudi Arabia, in order to develop hypotheses and formulate precise criteria for mobile computing evaluation. In order to achieve these aims, the researcher created a focus group by recruiting eight participants with solid background knowledge of usability engineering and mobile computing. The focus group proposed a four-phase process: determination, qualification, categorization and evaluation of the mobile computing applications developed by Saudi organizations. During the determination phase, two hundred and twenty seven (n=227) mobile applications were determined as having been developed by organizations in Saudi Arabia. During the qualification phase, one hundred and forty two (n=142) mobile applications were qualified. Within the categorization phase, the experts categorized only the qualified applications into a two-level categorization hierarchy. Finally, in the evaluation phase, the qualified applications were evaluated in terms of purpose, platform, visual appearance, content, organization and usability. The results herein revealed that 43% of the mobile applications in Saudi Arabia were M-Government applications, while 57% were M-Business applications. In addition, the study proposed a sample of thirty six (n=36) applications as having statistical significance from all of the mobile applications in Saudi Arabia.

***Index Terms*—**Mobile Computing; Saudi Arabia; Exploratory; Mobile Business; Mobile Government

I. Introduction

Mobile computing is a rapidly growing market. To illustrate, the annual number of smart phones shipped to consumers is greater than the combined sales of automobiles and personal computers [1]. In Saudi Arabia, the number of mobile phone subscriptions reached 53 million in 2013, representing a population penetration rate of 181.6% [2]. In fact, the widespread adoption of mobile computing has motivated Saudi government and business organizations to deliver online services, through the use of smart phones; as a result, users are now able to install applications on their mobile operating systems which facilitates seamless and instant access to data anytime/anywhere [3]. Although the potential of mobile computing is well recognized, few studies have investigated the way in which these trends and key attributes have developed in Saudi Arabia; thus, a clear gap in the literature was identified.

This study attempts to overcome these gaps by exploring the status and trends of mobile computing in Saudi Arabia. Consequently, this research will be of great interest to IT managers in Saudi Arabia, especially for those interested in migrating their business processes to mobile enterprise environments, or for those with specialist interests in mobile computing design and development. It will contribute to the literature on Information Systems (IS) by exploring dominant characteristics of mobile applications and by providing insight into key trends in mobile computing. As exploratory research is of broad focus in nature, it is important to clearly define the objectives. Therefore, the objectives of this study involved the formulating of hypotheses to direct further research in the field, by showing the differences between mobile computing types (M-Government and M-Business). Another objective involves proposing a sample of mobile applications in Saudi Arabia which are truly representative of the population, with statistical significance, in order to facilitate sample selection in future mobile computing studies. In addition, the study will provide a two-level categorization hierarchy of mobile applications in Saudi Arabia, along with application ranking and evaluation. As such, it is important to note that this paper is an extended version of an earlier conference paper [4].

The remainder of this paper will be organized as follows. The next, second, section will present a literature review on mobile computing, and an exploratory study will be presented in the third section. Section four will identify the results, section five will provide discussions as well as the implications of this research, and, finally, conclusions will be provided in section six.

II. Literature Review

The main concept behind mobile computing is that it provides the ability for users to access data and information remotely from portable devices, in an anywhere and anytime capacity, all of which have been aided by developments in wireless communications and technologies [5]. Sharma and Kasana (2010) argued that there are two types of mobility: terminal and personal mobility [6]. The former denotes the ability of a mobile unit to access information and data anywhere and anytime, while the latter refers to the ability of the user to establish a connection to access their desired services from any device which is supported by identification and authentication elements. With the rapid increase in network speed and capabilities, alongside the decreases

observed in mobile device prices, the use of mobile computing has become one of the most feasible and effective opportunities for many enterprises [7]. It is expected that computing for mobile workers will reach its peak of maturity and feasibility in the near future, this is fueled by the widespread adoption of new mobile applications as well as developments in the speed and coverage of wireless networks which have resulted in increased usability and user acceptance of mobile computing [8, 9].

Although mobile computing is regarded as an emerging trend in Information and Communication Technologies (ICT) research and practice, it has been developing for more than three decades. Kjeldskov (2013) argued that mobile computing evolves by means of six significant waves, including: portability, miniaturization, connectivity, convergence, divergence and apps [10]. The portability wave placed a significant technological focus on reducing the size of computers by producing portable and location-independent devices, such as laptop computers that are easily moveable from one location to another. The miniaturization wave focused on the facilitation of the use of smaller devices by mobile users, while the aim of the connectivity wave was to facilitate wireless communications between mobile users and their use of particular applications. The convergence wave targeted the integration of previously distinct technologies, which evolved alongside the use of stronger inter-connection and similar goals, such as cameras, music players and mobile phones. The divergence wave placed a greater focus on single functions, by producing gadgets that perform particular tasks. Most importantly, the apps wave focused on the software side by providing end-users with a wide variety of interactive functionality on their mobile devices, including E-mails, data access applications, games and specialized content. This emphasizes the importance of the current wave in mobile computing evolution, including the increased role that mobile applications play in improving user experience and facilitating mobile interaction design.

Mobile computing can be useful in several application areas. A common description of mobile application categories focuses on horizontal and vertical applications [11]. The former refers to standard types of applications that are usually offered within an operating system, such as E-mail, web browsing, to-do list and calendar functionalities, while the latter denotes the industry specific applications which have a transaction processing nature; specifically, they are usually connected to corporate databases and serve particular functionalities, such as retailing, sales and marketing. Categorized by the industry or sector, scholarly research suggested several application areas for mobile computing. For example, York and Pendharkar (2004) identified several mobile computing industries and application areas [12]. The application areas of mobile computing were ordered by the magnitude of research in each area; in particular: field services, sales forces, healthcare, field work, insurance claims and journalism, with a number of elephant articles in the field service industry and one article which identified the insurance claim and journalism industries [12]. Another suggestion of mobile application areas by Joshi (2014) included the areas of: news reporting, transportation and shipping, emergencies, business and education [11]. A recent study by Monares et al. (2011) investigated the use of mobile computing in emergency situations and found that by providing firefighters with a low-cost collaborative mobile application the control of emergency situations could be improved and it could even help to overcome several problems faced by firefighting units [13]. More recently, a study by Lawrence and Sankaranarayanan (2014) utilized mobile computing to facilitate the searching of hotels, it then presented the retrieved search results on mobile digital maps [14]. Another application of mobile computing was provided by Chong et al. (2014), specifically they presented a prototype of a mobile phone that performed the basic functions of a computer keyboard and mouse by utilizing wireless communications and a touch-pad [15].

As an emerging trend in the computing field, mobile technologies face several challenges with regard to different aspects. For example, a study by Mengshoe (2013) suggested that the current practice of mobile computing is concerned with four major challenges: robustness of the wireless networks, the effect of increasing demand on mobile service responsiveness, power management issues and the complexity of mobile application development environments [16]. Another example, by Joshi (2014), discussed the impact of network quality and usability in mobile computing environments [11]. In terms of mobile device constraints, the author listed: slow response time, low average throughput, poor coverage and rapid battery consumption, as issues. However, the recent advances in wireless networks, including fourth generation (4G) technologies, have resulted in wireless connectivity becoming simpler, more intelligent and more trustworthy. In the usability constraints, screen size and means of input were listed as posing challenges to mobile interaction design. Another concern, raised by Hammershoj et al. (2010), acknowledged the fact that mobile application development is reliant on heterogeneous platforms that are driven by different and competing companies – this can and has resulted in a lack of integration and interoperability [17]. This argument is in agreement with the work by Dehlinger and Dixon (2011) who presented on mobile application development challenges, including: mobile interaction design, context-awareness and the balance between agility and requirement engineering [18]. In summary, mobile computing environments face numerous challenging issues, including application integration, mobile interaction design, power management, resource allocation and the lack of context-awareness.

The increased research in mobile computing demonstrates that this field is of significant importance. Over the past years, several studies have investigated the evaluation of mobile applications by drawing different conclusions. For example, Po et al. (2004) addressed the issue of usability evaluation for mobile technologies

using heuristic evaluation, they presented contextual influences to bridge the realism gap [19]. In particular, the study proposed that the usability evaluators should be considered when evaluating mobile applications in order to control the variation in the context interpretation. A study by Kjeldskov and Stage (2004) proposed six techniques for mobile computing evaluation in controlled environments with regard to physical activities; they found that movement and navigation, while using mobile applications, could cause several usability issues, like missing a button in the interface [20]. Another study by Zhang and Abidat (2005) proposed a generic framework for the usability testing of mobile applications according to the nature of the application; several challenges were identified with regard to mobile context, multimodality, connectivity, small screen size, different display resolutions, limited processing capabilities and power, and restrictive data entry methods [21]. In addition, Kaikkonen et al. (2005) examined the differences between usability studies of mobile applications in two environments: laboratory and field evaluations; they found that the same usability issues were identified in both environments [22].

More recently, a study by Verkasalo (2010), on the adoption of mobile computing, found that the motivation to use mobile applications depended on the application type, such as utilitarian motivations which drive the usage of mobile internet and map applications [3]. Franke and Weise (2011) proposed a framework of mobile computing quality assurance which provided key qualities of mobile applications, patterns of mobile applications development and metrics for mobile application testing [23]. A study by Alotaibi (2013) investigated the mobile service acceptance in Saudi Arabia, he found that Saudi Arabia was socially influenced in its adoption of mobile services [24]. The study assessed a mobile application in the financial services environment (entitled M-Tadawul), it revised the model of the unified theory of acceptance and use of technology (UTAUT). The results recommended further assessment of mobile applications in Saudi Arabia, because mobile applications have not, yet, been studied in depth in the country and no hypotheses have been formulated for best use. Another study by Anam et al. (2014) investigated the usability of adaptive mobile interfaces; specifically, they categorized interface elements and adapted web-based content in order to fit a tree-like mobile interface. The results of this usability study showed that this approach outperformed traditional mobile web interaction techniques [25].

III. Exploratory Study

A research project is considered to be exploratory when the purpose of the study is centered around the discovery of new insight [26]. Although exploratory research is relevant to the IS literature, it should be approached with extreme caution [27]. The decision to conduct exploratory research involves a trade-off. To illustrate, on one hand, it is argued that the exploratory method is of great value for researchers, due to its potential contributions toward the generation of new theories [28]; although, on the other hand, exploratory studies might produce theories that lack both usefulness and validity [28]. Another argument by Cheon et al. (1993) suggested that the choice of research method is reliant on the maturity of the topic [27]. For example, exploratory methods can be useful in less mature contexts, due to their role in describing and establishing the basic understanding of a problem [27]. Armstrong (1970) demonstrated that extreme care is required when conducting exploratory research, due to its inductive nature – thus, the data precedes the theory [28]. One of the suggestions to overcome this obstacle is to reduce the extent to which the exploratory work leads to conclusions, by also drawing additional elements from prior theories [28]. Another useful suggestion places a remarkable focus on data reliability, by recommending data gathering techniques that rely on a panel of experts [28]. Another suggestion might involve increasing the flexibility of the research model, so as to provide opportunities for exploring different aspects of the context at hand [26]. In particular, the creation of a broad and flexible research model might rely on a survey of relevant literature, a survey of existing practices, expert consultations and an analysis of similar models [26].

Exploratory research is useful for the initial understanding of new phenomena, where the focus is broad and key issues have not, as yet, been identified [26]. One of the tools for conducting exploratory research is focus groups, as they represent group judgments which are gathered over the integrated views and perceptions toward a concept [29]. In usability engineering, focus groups are used as a survey method to collect the user's views and motivations to use a software [30]. In the focus group, the researcher usually acts as a facilitator whose responsibilities include initiating and monitoring the group meeting sessions [29]. The facilitator controls the interactions among the group members by processing session outcomes and by identifying conflicting viewpoints [29]. Sessions of focus groups can be tapped or videoed, if permission from all group members is granted [29].

There are several advantages and disadvantages to the use of focus groups; to illustrate, they are useful to generate novel ideas and they can clearly explain concepts [29], they can also improve the credibility of the research, as they eliminate biases which can occur in interviews [31]. It also improves survey result explorations and explanations, and they can contribute to the process of questionnaire design through the analysis of common experiences identified in the group discussions [32]. It is also considered to be cheap, less time consuming and quick and easy to be organized, compared to observation techniques [31]. On the other hand, the facilitator requires an extensive experience in discussion panel management in order to avoid common problems in the discussions [33]. Furthermore, several inter-personal issues can emerge, such as dominance of a group member or withdrawal of an inhibited group

member because of the group's dynamics [29]. In addition, group thinking problems could be encountered, as such there could be a tendency of individuals to satisfying other group members which could lead to them expressing views that may be incorrect [33].

This paper introduced an exploratory study of mobile computing trends in Saudi Arabia. In particular, it has identified particular aspects of mobile presence by exploring further explanations of, and about, the status and the current practice of mobile computing. In order to explore the mobile computing trends, a focus group of eight (n=8) mobile computing specialists was created. The focus group included four men and four women in order to control the effect of gender. The group was also representative of four different levels of skill and knowledge: bachelor students, master students, PhD candidates and mobile computing practitioners. For each knowledge level, there was one male and one female who were working independently. As recommended by Armstrong (1970) [28], this study placed a great deal of emphasis on data reliability by creating a focus group of experts, from mobile computing contexts, with different experience and knowledge levels. In addition, the current study followed the suggestion, by Kothari (2004), that the research model should be kept broad in order to facilitate further exploration and explanation opportunities [26].

Initially, to generate a starting point, a brainstorming technique helped to identify the requirements for the exploratory study. The focus group proposed a process of mobile computing assessment, which consisted of four main phases: determination, qualification, categorization and evaluation. The determination phase aimed to collect as many mobile computing practices as possible by searching application markets, such as App Store and Google Play. In the qualification phase, each mobile application was assessed, in turn, by the focus group in order to determine whether it qualified for further evaluation. The qualified applications were those developed by organizations; furthermore, any counterparts that had been developed by individuals were disqualified. In the categorization phase, the qualified mobile applications were categorized based on common attributes, such as sector, main activities, etc. This phase resulted in a two-level categorization hierarchy of the mobile applications. During the evaluation phase, the qualified applications were individually assessed by the focus group members. In brief, a four-phase process was followed to explore the level of adoption, trends and main attributes of mobile computing.

While implementing the proposed process the initial search of the application markets revealed thousands of irrelevant applications, which were retrieved during the determination phase. Therefore, the search for mobile applications in Saudi Arabia utilized official indexes provided by Saudi websites, such as the E-Government index [34], the Stock Market index [35] and the Ministry of Commerce index [36]. The focus group members searched all of the mobile application stores, they noticed that some of the applications appeared in the different stores under different names. The output of the determination phase identified a total of two hundred and twenty seven (n=227) mobile applications, all of which had been developed by organizations in Saudi Arabia. During the qualification phase, several applications were found to be: lower than the desired levels, duplicated versions or developed by individuals. The qualification phase identified a total of one hundred and forty two (n=142) mobile applications. Based on the sector, the categorization phase divided these applications into two types: M-Government and M-Business. Based on their main activities, the applications of each type (category) were then categorized into eight (n=8) sub-categories resulting in a total of sixteen sub-category (n=16). The output of the categorization phase resulted in a two-level categorization hierarchy, see Table 1, which demonstrates that the sub-categories were ranked based on the number of mobile applications in each one (N), and their percent.

Table 1. The categorization hierarchy with the sub-categories ranked based on the number of mobile applications in each one (N) and the percent

Category	Seq.	Sub-Category	Rank	Applications (N)	Percent (%)
M-Government	1	Ministries	10	7	4.9%
	2	Education	8	9	6.3%
	3	Authorities	11	4	2.8%
	4	Health	12	4	2.8%
	5	Corporations	15	3	2.1%
	6	Other agencies	4	12	8.5%
	7	Government services	5	11	7.7%
	8	Government content	6	11	7.7%
M-Business	9	Banks and financial services	1	18	12.7%
	10	Energy and utilities	16	3	2.1%
	11	Retail and commerce	9	8	5.6%
	12	Information and Communication Technology (ICT)	13	4	2.8%
	13	Media and publishing	3	16	11.3%
	14	Other businesses	7	11	7.7%
	15	Business content	2	17	12.0%
	16	Business services	14	4	2.8%
Total				142	100%

The evaluation of these mobile applications utilized an instrument devised specifically for this study; this instrument considered the following three parts: purpose, platform and evaluation. As recommended by Kothari (2004), it is important to reduce the exploratory efforts in order to ensure conclusion reliability and validity. Several elements of which were derived from prior research [26]. For example, mobile services can be regarded as an evolution of online services [37]; thus, the purpose of deploying a mobile application is similar to that of a web-based system. Alotaibi and Alzahrani (2004) suggested some of reasons why an organization may have a web presence, such as for advertising purposes, for displaying content, or for facilitating transaction processing [38]. Consequently, in terms of the research instrument, the aim of the first part was to determine the purpose of the mobile application as being one of three multiple choice answers: advertising only, displaying content and transaction processing. In terms of the second part of the research instrument (mobile platform), Godwin-Jones (2008) argued that Apple devices running in iOS, and others using Andriod as an open source operating system, have a vital role to play in the future of mobile application development [39]. This argument is in agreement with the conclusions presented by Hall and Anderson (2009), Hammershoj et al. (2010) and Huang (2011), they all noted that the iOS and Android are among the most dominant operating systems in mobile computing environments [17, 40, 41]. The three major mobile platforms of iOS, Android and other OS were identified in the current literature as the platforms representing the most popular mobile operating systems. As per for the third part (mobile application evaluation), derived from the common website assessment measures, the measures in this study were tailored to fit the context of mobile presence [42, 43]. Visual appearance, content, organization and usability were found to be adequate for initial evaluation of mobile applications. Therefore, each member of the focus group was asked to independently rate the mobile application, in terms of its visual appearance, content, organization and usability, using a ten-point scale ranging from very weak (1) to excellent (10). Conflicting rating results were then resolved through the use of short meetings and discussion panels, all of which were supervised by the author. In summary, this study utilized an instrument comprised of three parts to quantitatively assess the mobile presence in Saudi Arabia. The evaluation of the mobile applications is displayed in Appendix A, along with the ranking results.

IV. Results

Fig. 1 shows the mobile computing trends in Saudi Arabia, in terms of type, purpose, platform and evaluation. At a glance, it can be noticed that M-Business, content display and iOS were the most dominant trends with a service quality level that was more than 74% in terms of the application's visual appearance, organization, usability and content. In terms of the type of mobile computing, it was found that Saudi businesses were more progressive in their mobile computing than the government, with a score of 57% for M-Business, which is 15% higher than that for M-Government. In terms of mobile computing adoption, it can be seen that all of the organizations, both public and private, utilized mobile computing to display content, compared to 44% of the organizations which utilized mobile computing for transaction processing and 17.6% for advertising only. With regard to platform trends, iOS was the most dominant OS in mobile computing, with 95.1% of the mobile applications running on iOS, compared to 59.9% running on Android and 17.6 running on other OS, such as Windows phone and Blackberry. In terms of the evaluation of the quality of mobile computing services, all of the evaluation factors were rated above 74%, which is a very good indicator of the mobile application's usability and visual appearance as well as of its content and organization. The overall score for mobile computing was consistent with the scores for the four evaluation factors which reflected a balanced implementation of the mobile applications.

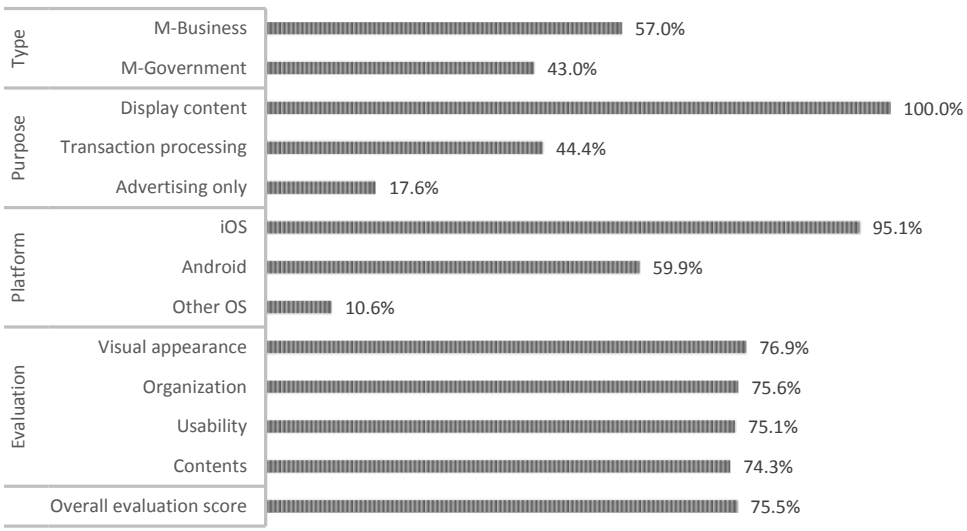

Fig. 1. Mobile computing trends in Saudi Arabia, in terms of type, purpose, platform and evaluation

Fig. 2 shows the mean values of mobile computing characteristics, including platform (a), purpose (b), and evaluation (c), for both M-Government and M-Business. At a glance, it can be seen that the characteristics of mobile presence varied between M-Government and M-Business, with a particularly consistent difference in favor of M-Business in terms of the mobile presence evaluation factors. In Fig. 2 (a), it can be seen that iOS is the most dominant mobile platform, with a penetration rate of 98% and 92% for the M-Business and M-Government applications, respectively. In terms of Android penetration, the frequency values represent a different picture with the number of M-Government applications running on Android (67%) being higher than for M-Business (54%). This implies that M-Government is more reliant for open source mobile platforms when compared with M-Business. Nevertheless, Android was identified as the second dominant mobile platform in the Saudi market. To illustrate, 14% of the M-Business applications run on other platforms, such as Windows phone and Blackberry, compared to 7% for M-Government applications. In Fig. 2 (b), it is clear that display content forms a common purpose of mobile presence in Saudi organizations, with all the M-Government and M-Business aiming to show their relevant contents to mobile users. The figure also showed that 22% of the M-Business organizations adopted mobile computing for advertising only, compared to 11% for M-Government. This implies that M-Government has taken the adoption of mobile computing more seriously than M-Business. This finding is also supported by the status of mobile applications being transaction-oriented, which compares favorably to M-Government. In particular, 61% of M-Government applications were identified to be transaction processing in nature, which represents almost double the transactional applications for M-Business (32%). In Fig. 2 (c), the results herein showed that M-Business was consistently of higher quality than M-Government with regard to all aspects of evaluation: visual appearance, contents, organization and usability. The value for M-Business was approximately 4% higher than that for M-Government. In summary, the results herein revealed a clear variance in the trends and characteristics of mobile presence, these differences were clearly observed in the adoption behavior of government and business organizations in Saudi Arabia.

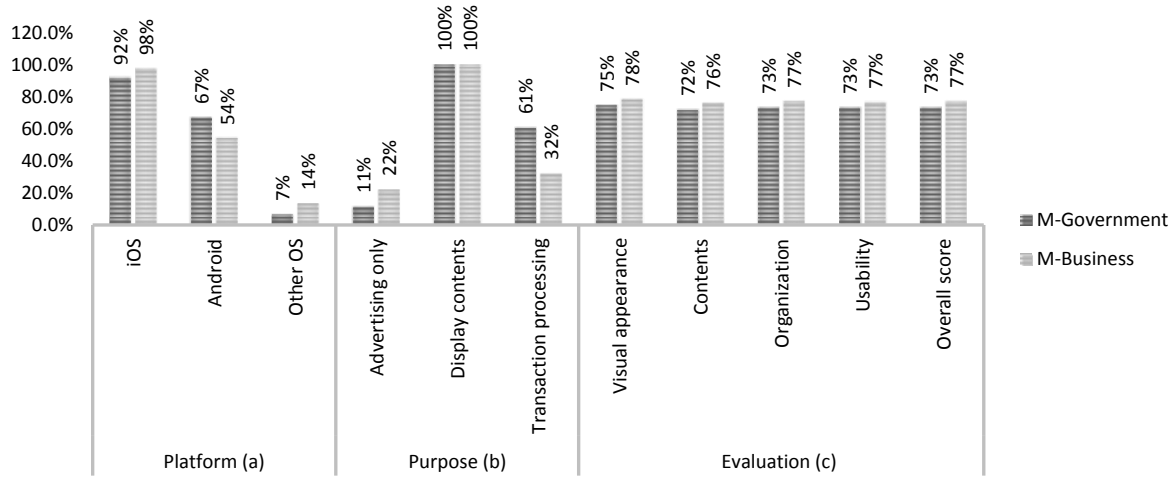

Fig. 2. Mean values of mobile computing trend and characteristics, including platform (a), purpose (b) and evaluation (c) for both M-Government and M-Business.

V. Discussion

The purpose of this research was to formulate hypotheses, it is therefore important to identify the elements of mobile computing which are more progressive. The number of applications in M-Business was higher than in M-Government, which implies that M-Business is more progressive. However, this indicator cannot be trusted alone, as there are more private organizations than government ones. Therefore, it is important to consider a representative sample of mobile computing applications. With the aid of data mining tools, labeled SPSS Clementine, a sample representing all of the mobile computing applications was generated using the K-Mean clustering approach. The aim was to identify the quality levels and a set of applications that could serve as a prototype of each quality cluster. This resulted in a sample of thirty six (n=36) mobile applications, which were equally representative of M-Government and M-Business. This sample is shown in Table 2. Differences between the sample and the population were examined using a t-test. The t-test results showed no significant differences between the sample and the population (t_{1134}= 1.273, cv=1.960, p>0.05).

The sample was utilized to run several statistical tests for the different evaluation factors, in order to formulate hypotheses. The first t-test examined the differences between M-Business and M-Government. The t-test results showed that M-Business adoption was of higher quality than that for M-Government (t_{1134}= 3.813, cv=1.960, p<0.001). The t-test results showed that M-Business was of higher quality than M-Government in terms of usability (t_{1134}= 2.679, cv=1.960, p<0.001) and attractiveness (t_{1134}= 3.422, cv=1.960, p<0.001). The t-

test results also showed that the content in M-Business was richer (t_{1134}= 3.856, cv=1.960, p<0.001) and more organized (t_{1134}= 3.599, cv=1.960, p<0.001) than that in M-Government. Therefore, three hypotheses of mobile computing in Saudi Arabia were proposed:

Table 2. The sample of thirty six (n=36) mobile applications, which were equally representative of M-Government and M-Business.

Category	Seq.	Name	Rank	Score		Seq.	Name	Rank	Score
M-Government	1	Ministry of Commerce and Industry (MCI)	55	79.1%		19	King Fahad Medical City (KFMC)	47	80.3%
	2	Ministry of Foreign Affairs (MOFA)	30	83.1%		20	Saudi Post Corporation	121	63.4%
	3	Ministry of Health (MOH)	15	89.1%		21	Saline Water Conversion Corporation (SWWCC)	23	85.3%
	4	Ministry of Higher Education (MOHE)	98	72.8%		22	National Information Center (NIC) at MOI	78	75.3%
	5	Ministry of Labor (MOL)	91	73.4%		23	Riyadh Chamber of Commerce and Industry	69	76.6%
	6	King Fahd University of Petroleum & Minerals (KFUPM)	130	59.4%		24	Saudi Arabian Airlines (Saudia)	92	73.4%
	7	Taibah University	110	69.4%		25	Saudi e-Government (Yesser)	12	90.0%
	8	Saudi Food & Drug Authority (Saudi FDA)	111	68.4%		26	General Directorate of Civil Defense	65	77.5%
	9	Saudi Arabian General investment Authority (SAGIA)	125	62.2%		27	Saudi Press Agency (SPA)	114	67.5%
M-Business	10	Al-Rajhi Bank	8	91.3%		28	Saudi Company for Hardware (SACO)	48	80.3%
	11	Albilad Bank	42	81.3%		29	Mobily for Individuals	52	80.0%
	12	Saudi Electricity Company (SEC)	22	85.6%		30	Saudi Telecom Company (STC)	2	96.3%
	13	Saudi Automotive Services Co. (SASCO)	20	87.5%		31	al-jazirah newspaper	67	77.2%
	14	E-Mall	142	40.0%		32	Al-Riyadh newspaper	24	85.3%
	15	eXtra Stores	1	96.3%		33	Arab News	66	77.5%
	16	Othaim Markets	40	81.6%		34	Aleqtesadiah newspaper	14	89.4%
	17	Jarir Bookstore	138	52.5%		35	Al Tayyar Travel	135	58.1%
	18	Panda	59	78.4%		36	Solidarity Saudi Takaful	88	74.1%

H1: M-Business is more progressive in mobile computing than M-Government.

H2: M-Business is more usable and attractive than M-Government.

H3: M-Business content is richer and more organized than M-Government.

One of the contradictory issues identified during the course of this research found M-Business to be more progressive than M-Government, despite the fact that mobile presence is not taken as seriously by private organizations. In fact, the number of mobile applications developed by business organizations was greater than those developed by government organizations; furthermore, the evaluations compared favorably to the M-Business presence. However, the purpose for M-Business was concerned more with advertising and several applications were non-transactional in nature. An in-depth analysis showed that a great deal of M-Business applications belonged to small and medium enterprises (SMEs) which adopted a mobile presence, but which lacked links with databases. Further investigation of these SMEs showed that their mobile applications were of a non-transactional nature, because the SMEs had no corporate databases; nonetheless, they still launched a mobile application. To illustrate, there was one case of a small food chain restaurant that launched its mobile application to show their menu to their customers; unfortunately, the restaurant had scattered databases which couldn't be linked to the web or mobile channels. As a result, the current research excluded these SMEs and similar cases from the proposed sample for mobile computing applications, because they were not truly representative and could have led to misleading results and false conclusions.

This study has identified several implications that are of relevance to the theory and practice of mobile computing. For researchers, it provides insight into the similarities and differences between M-Government and M-Business practices in Saudi Arabia. It supports further studies in the mobile computing field by proposing a sample of mobile applications that represents the population with statistical significance. For practitioners, the study showed trends and general characteristics of mobile computing practice in Saudi Arabia. For example, it is noteworthy that the displaying of content was the most dominant purpose of mobile computing adoption, yet the evaluation of the content displayed was actually rated lower than other factors. It also revealed dominant mobile platforms, by explaining major mobile presence

purposes and showing key evaluation factors, such as usability, organization, content and visual appearance. The experience gained from this study suggests that Saudi organizations should embrace the development of mobile computing by considering the general trends and key characteristics of mobility practices.

Further research in this area could progress in different directions, such as usability heuristic evaluation of mobile computing and user acceptance testing of mobile applications in both government and private businesses.

VI. Conclusion

Recent advances in the theory and practice of IT indicate that mobility is an emerging trend in the computing field. This study investigated the major trends in mobile computing by providing insight into key characteristics and quality levels of mobile computing practices in Saudi Arabia. Based on a four-phase process, mobile applications developed by Saudi organizations both governmental and in private businesses were evaluated by a focus group of eight, all of which were experts in the fields of mobile computing and usability engineering. The output from this study included a two-level categorization hierarchy of mobile applications in Saudi Arabia. Furthermore, the study proposed a representative sample of the population of mobile applications in Saudi Arabia, this included equal numbers for M-Government and M-Business practices, with eighteen applications each. The study also formulated three hypotheses of the differences between M-Government and M-Business practices in Saudi Arabia, these hypotheses could be utilized to help direct further research in the mobile computing field. All of the mobile applications that were qualified to be part of this study were then ranked in order to demonstrate the variations between the different sectors. Finally, implications for research and practice were highlighted, along with directions for further research.

Appendix A. The Evaluated Mobile Applications

Table 3. The evaluated mobile applications ranked based on the overall evaluation score.

Category	#	Name	Sub-category	Rank	Score
M-Government	1	Ministry of Commerce and Industry	Ministries	55	79.1%
	2	Ministry of Transport (MOT)	Ministries	58	78.4%
	3	Ministry of Foreign Affairs	Ministries	30	83.1%
	4	Ministry of Health	Ministries	15	89.1%
	5	Ministry of Higher Education	Ministries	98	72.8%
	6	Ministry of Islamic Affairs, Endowments, Dawah and Guidance	Ministries	107	70.0%
	7	Ministry of Labor (MOL)	Ministries	91	73.4%
	8	Islamic University	Education	119	66.3%
	9	King Fahd University of Petroleum & Minerals (KFUPM)	Education	130	59.4%
	10	Princess Nora bint Abdul Rahman University	Education	109	69.4%
	11	Qassim University	Education	103	71.3%
	12	Taibah University	Education	110	69.4%
	13	Jubail Industrial College	Education	117	66.9%
	14	E-Learning Deanship at Imam University	Education	77	75.3%
	15	Library at KFUPM	Education	79	75.0%
	16	Female Teaching Center at KSU	Education	49	80.0%
	17	Saudi Food & Drug Authority (Saudi FDA)	Authorities	111	68.4%
	18	Saudi Commission for Tourism and Antiquities (SCTA)	Authorities	122	63.1%
	19	Saudi Arabian General Investment Authority (SAGIA)	Authorities	125	62.2%
	20	Saudi Professional League (SPL)	Authorities	50	80.0%
	23	King Fahad Specialist Hospital (KFSH)	Health	123	62.5%
	24	King Fahad Medical City (KFMC)	Health	47	80.3%
	25	Saudi Physical Therapy Association (SPTA)	Health	81	75.0%
	26	Emergency Call Center by MOH (call 937)	Health	41	81.3%
	27	Technical and Vocational Training Corporation (TVTC)	Government corporation	129	61.3%
	28	Saudi Post Corporation	Government corporation	121	63.4%
	29	Saline Water Conversion Corporation (SWWCC)	Government corporation	23	85.3%
	21	Holy Makkah Municipality	Other agencies	72	75.6%
	22	Municipality of Eastern Region	Other agencies	80	75.0%
	30	National Information Center (NIC) at MOI	Other agencies	78	75.3%
	31	Riyadh Chamber of Commerce and Industry	Other agencies	69	76.6%
	32	Saudi Arabian Airlines (Saudia)	Other agencies	92	73.4%
	33	Saudi Arabian Cultural Mission in New Zealand	Other agencies	54	79.4%

	34	Saudi E-Government (Yesser)	Other agencies	12	90.0%
	35	General Directorate of Civil Defense	Other agencies	65	77.5%
	36	Saudi TV Channel 1	Other agencies	140	43.8%
	37	Quran Radio	Other agencies	33	82.5%
	38	Real-Estate Development Found at Eastern Province	Other agencies	25	85.0%
	39	Saudi Press Agency (SPA)	Other agencies	114	67.5%
	40	Critical Locations Service by Riyadh municipality (Hather)	Government services	108	70.0%
	41	Staff Services by KSU	Government services	93	73.1%
	42	Student Services by KSU	Government services	126	61.9%
	43	Postal Address Locator by Saudi Post	Government services	115	67.5%
	44	Tourism Navigator by SCTA	Government services	34	82.5%
	45	Geographic Notifications by Jeddah Municipality	Government services	94	73.1%
	46	Riyadh Municipality Notifications	Government services	73	75.6%
	47	Government Notifications (Ishaar) by MOI	Government services	86	74.4%
	48	Water Notifications by Ministry of Water & Electricity	Government services	112	68.1%
	49	Commercial Violation Notification Service by MCI	Government services	26	85.0%
	50	Riyadh Map (Wsef) by Riyadh Municipality	Government services	70	76.3%
	51	Calendar of Events by SCTA	Government services	104	71.3%
	52	Electronic Directory by MOH	Government content	100	71.9%
	53	Saudi School Curricula by MOE	Government content	68	76.9%
	54	National Plan for CIT (Tahawul) by MCIT	Government content	82	75.0%
	55	Saudi Shelter Guide by SCTA	Government content	71	76.3%
	56	Saudi Laws by Bureau of Investigation and Prosecution (BIP)	Government content	101	71.9%
	57	Riyadh Directory by Arriyadh Development Commission	Government content	83	75.0%
	58	Jeddah Explorer to Licenses of Digs	Government content	120	63.8%
	59	Riyadh Book Fair by Ministry of Culture and Information	Government content	95	73.1%
	60	Index of Consumer Goods by MCI	Government content	99	72.5%
	61	Indicators of Higher Education by MOHE	Government content	74	75.6%
M-Business	62	Al-Rajhi Bank	Banks & Financial Services	8	91.3%
	63	National Commercial Bank (NCB)	Banks & Financial Services	21	85.6%
	64	Albilad Bank	Banks & Financial Services	42	81.3%
	65	Alinma Bank	Banks & Financial Services	6	92.2%
	66	Arab National Bank (ANB)	Banks & Financial Services	3	93.4%
	67	Banque Saudi Fransi	Banks & Financial Services	45	80.6%
	68	Riyad Bank	Banks & Financial Services	16	88.8%
	69	Saudi British Bank (SABB)	Banks & Financial Services	56	78.8%
	70	Saudi Investment Bank (SAIB)	Banks & Financial Services	51	80.0%
	71	Samba	Banks & Financial Services	4	92.5%
	72	Saudi Hollandi Bank	Banks & Financial Services	10	90.6%
	73	Aljazera Bank	Banks & Financial Services	9	91.3%
	74	Saudi Fransi Capital	Banks & Financial Services	17	88.8%
	75	Al Rajhi Capital	Banks & Financial Services	11	90.6%
	76	Mobily Mubasher	Banks & Financial Services	27	85.0%
	77	Samba Tadawul	Banks & Financial Services	28	85.0%
	78	Saudi Hollandi Capital	Banks & Financial Services	31	83.1%
	79	Tadawul	Banks & Financial Services	18	88.1%
	80	Saudi Electricity Company (SEC)	Energy & Utilities	22	85.6%
	81	Saudi Automotive Services Co. (SASCO)	Energy & Utilities	20	87.5%
	82	Saudi Lighting Company	Energy & Utilities	131	59.4%
	83	E-Mall	Retail & Commerce	142	40.0%
	84	eXtra Stores	Retail & Commerce	1	96.3%
	85	Othaim Markets	Retail & Commerce	40	81.6%
	86	Jarir Bookstore	Retail & Commerce	138	52.5%
	87	Obeikan Store	Retail & Commerce	96	73.1%
	88	Panda	Retail & Commerce	59	78.4%
	89	Saudi Company for Hardware (SACO)	Retail & Commerce	48	80.3%
	90	Bin Dawood Markets	Retail & Commerce	134	58.1%
	91	Mobily for Business	ICT	87	74.4%

92	Mobily for Individuals	ICT	52	80.0%
93	Saudi Telecom Company (STC)	ICT	2	96.3%
94	Zain	ICT	13	89.4%
95	Panorama FM	Media and Publishing	46	80.6%
96	Al Arabiya	Media and Publishing	5	92.5%
97	MBC FM	Media and Publishing	60	78.1%
98	MBC NOW	Media and Publishing	75	75.6%
99	al hayat Newspaper	Media and Publishing	37	81.9%
100	Alyaum Newspaper	Media and Publishing	43	81.3%
101	al-jazirah Newspaper	Media and Publishing	67	77.2%
102	Al-Riyadh Newspaper	Media and Publishing	24	85.3%
103	Arab News	Media and Publishing	66	77.5%
104	Arriyadiyah	Media and Publishing	89	73.8%
105	Sabq	Media and Publishing	29	83.8%
106	Saudi Gazette	Media and Publishing	61	78.1%
107	Aleqtesadiah Newspaper	Media and Publishing	14	89.4%
108	Hasa Newspaper	Media and Publishing	139	47.5%
109	Arriyadiyah Newspaper	Media and Publishing	57	78.8%
110	Alweeam Newspaper	Media and Publishing	84	75.0%
111	Al Tayyar Travel	Other businesses	135	58.1%
120	Mahd alburaq	Other businesses	141	43.1%
112	Aljomaih Automotive	Other businesses	132	58.8%
113	Solidarity Saudi Takaful	Other businesses	88	74.1%
114	Tawuniya	Other businesses	62	78.1%
115	Munch Bakery	Other businesses	124	62.5%
116	Alromansiah Restaurants	Other businesses	32	83.1%
117	Effat University	Other businesses	127	61.9%
118	SABIC	Other businesses	116	67.5%
119	Spring Rose	Other businesses	118	66.9%
121	Al-dawaa Pharmacy	Other businesses	53	80.0%
122	Islamic Development Bank Group Business Forum - THIQAH	Business content	128	61.9%
123	Abyat by STC	Business content	97	73.1%
124	Argaam	Business content	35	82.5%
125	Asrar STC	Business content	90	73.8%
126	Government Directory by Mobily	Business content	105	71.3%
127	Deeni Yaqini by STC	Business content	44	81.3%
128	Hajj Application by Mobily	Business content	63	78.1%
129	Donation by STC	Business content	113	68.1%
130	Saudi Green Building Forum	Business content	133	58.8%
131	Quality Forum by SEC	Business content	136	56.3%
132	Your Health	Business content	106	71.3%
133	Your Eye Health	Business content	137	54.4%
134	Iktissab by Othaim Markets	Business content	76	75.6%
135	Lamsa	Business content	36	82.5%
136	STC Library	Business content	19	88.1%
137	Alhilal Football Club by Mobily	Business content	64	78.1%
138	Dawri Plus by STC	Business content	7	91.9%
139	Aramco Job	Business services	102	71.9%
140	SABIC Materials Selector	Business services	38	81.9%
141	SABIC PP Finder	Business services	39	81.9%
142	Rassid by SEC	Business services	85	75.0%

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