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Persuasive Strategies in Mobile Healthcare: A Systematic Literature Review

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Abstract: Topics related to recent advances in persuasive technology have been of great interest in many areas of computational technologies. Persuasive technology focuses on how to change the attitudes or behavior of users. Nowadays, persuasive strategies are gradually integrated into the design of software. However, the key strategies for the integration are still unclear while few categorizations or frameworks have been proposed. This study describes an extensive review upon the key question on how persuasive systems should be designed in ensuring that the system interacts with individual users in changing their behaviors. The main aim of this study is to identify the key persuasive strategies for mobile healthcare systems. It argues the existing related researches that portray how the persuasive strategies are integrated with the system development. To this end, it indicates that a set of guidelines for the adoption and implementation of persuasive strategies in mobile healthcare is highly needed.

Key words: Persuasive technology, persuasive strategies, persuasive principles, human-computer interaction, mobile healthcare system, system development

INTRODUCTION

Interactive computer technology is useful in influencing users to alter their positions and conducts, since the computer has several special features and advantages of individual actions (Fogg, 2009; Salam *et al*., 2010). Such technology can be a processor like the computer system, piece of equipment or application that is designed to impact the thought or conduct of an individual (Fogg, 2003). Briefly, persuasive aspect of technology focuses on interactive computational technologies including desktop computers, mobile devices, tablet PCs, video games, internet services and social networks. Currently, persuasive technology has been found to be the integral parts of various fields including business, education and healthcare (Lehto *et al*., 2013).

Mobile health (m-Health) has been a topic of great interest worldwide. The key goal of most m-Health projects is to induce long-lasting behavioral change among healthcare providers, patients or both. In that regard, integrating persuasive strategies has a great potential for ensuring the effectiveness of m-Health solutions. However, the current literatures reveal that the list of persuasive strategies is still unclear (Kegel and Wieringa, 2014). Researchers face difficulties in implementing the strategies due to the vague support (Lehto *et al*., 2013; Kegel and Wieringa, 2014; Ahtinen *et al*., 2009). Therefore, the objective of this study is to review the key persuasive strategies in mobile healthcare and its implementation.

MATERIALS AND METHODS

This study begins by addressing its aims at reviewing the key persuasive strategies in mobile healthcare and its implementation. In order to accomplish that, a Systematic Literature Review (SLR) as adapted from Kitchenham and Charters (2007) has been conducted. It is a renowned method to identify, evaluate and interpret all related studies based on a certain research question, area of research or phenomenon of interest. Systematic literature review has usually achieved in formal mechanism, methodically executed and therefore, it differs from ordinary literature surveys. The gist reason to use SLR is to get credible, fair and impartial evaluation of a research topic. Therefore, an SLR is an appropriate research method for this study that aims to identify and evaluate the evidence regarding the benefits and limitations. All the detailed steps are described.

Development of review protocol: The review protocol is developed by following the guidelines, procedures and policies of Kitchenham and Charters (2007) and Kitchenham (2004). The protocol includes all the elements of the review plus some additional planning information,

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background, review questions, review objectives, data sources, search strategy, selection criteria and procedures, quality assessment checklists and procedures, data extraction strategy, synthesis strategy and project timetable. Consequently, this study has followed all the guidelines in order to get more reliable results.

Research questions

RQ1: What is the level of research activity on persuasive strategies in mobile healthcare?

RQ2: What are the key persuasive strategies in mobile healthcare?

RQ3: How the current persuasive strategies are implemented in mobile healthcare?

Search strategy and data sources: Before starting the search process, initial scoping study has been conducted to determine the resources to be searched and the search terms for the use of each resource. Based on the information that has been retrieved from the study, it will be used as a guide for the development and validation of the major search terms. Therefore, the search terms were incrementally modified during the scoping study. Consequently, the search strategy has determined six electronic databases in addition to search for the additional sources manually in Google Scholar to increase the probability of finding highly relevant articles. The most popular academic publishers are IEEE, ACM, Scopus, ScienceDirect, Springer and Web of Science. The electronic sources have been selected, since, they involve journals and conferences and also they provide the mechanism to perform a keyword search in an easy and effective manner. In this step, a fixed period of time has not been specified for making the search process. In addition, the search process only involved journals and conference proceedings that were published in English only.

The relevant articles were searched using the following search terms: ("software architecture" and "persuasive" and "health" and "mobile") or ("persuasive framework" and "health" and "mobile") or ("persuasive architecture" and "health" and "mobile") or ("persuasive model" and "health" and "mobile") or ("persuasive features" and "health" and "mobile") or ("persuasive principles" and "health" and "mobile") or ("persuasive strategies" and "health" and "mobile") or ("persuasive techniques" and "health" and "mobile"). All the search terms for the articles were combined by using the Boolean "OR" operator which entails that an article only has to include any one of the terms to be retrieved. Then, only the related articles to the key questions in the domain of mobile healthcare were selected.

Excluded from the search were editorials, prefaces, article summaries, interviews, news, reviews, correspondence, discussions, comments, reader's letters and summaries of tutorials, workshops, panels and poster sessions. The search strategy was based on several stages as described in the next study.

RESULTS AND DISCUSSION

This study discusses in detail the selected works based on the research questions. Q1; Level of the research activity on persuasive strategies in mobile healthcare. Based on the systematic literature review, a total of 457 articles have been identified based on keywords and databases including 81 duplicated articles. After eliminating the duplicates and carrying out the quality assessment based on the selection criteria, the total number of articles was 308. Among those 308 articles, 182 articles were not related to the healthcare domain, thus, they were excluded. The remaining 126 articles were further analyzed and it was found that only 40 articles were related to the persuasive strategies in mobile healthcare and architecture as shown in Fig. 1. Meanwhile, 3 out of 40 articles discussed only the concept of persuasive technology without any explanatory data (Lim *et al*., 2012; Lin *et al*., 2011; Soror and Davis, 2014). Based on year of publication, this review noticed that the research activities related to persuasive strategies in mobile healthcare have commenced, since 2006. However, since 2009 they already started to show some advancement. Since then, the attention on the research area grows steadily as shown in Fig. 2. A significant increase in the number of publications related to persuasive technology, especially in the last 3 years reflects the ability to evolve persuasive technology into interactive systems. This SLR also reveals that all articles related to persuasive technology in the mobile healthcare domain have been published in various sources. Figure 3 shown the number of publications by publishers which include IEEE, ACM, Science direct, Scopus and Springer. In the analysis phase of the relevant articles, frequency which refers to the number of persuasive strategies in mobile healthcare as appeared in the literatures is stated. Figure 4 shown the frequency of persuasive strategies in mobile healthcare literatures.

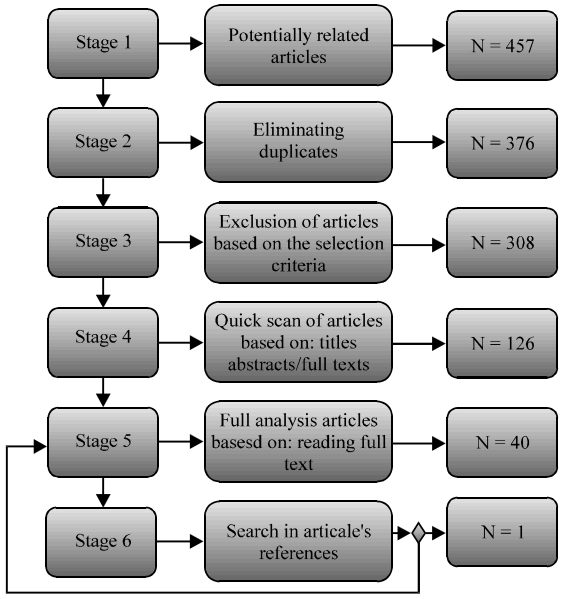

Fig. 1: The results of the search strategy

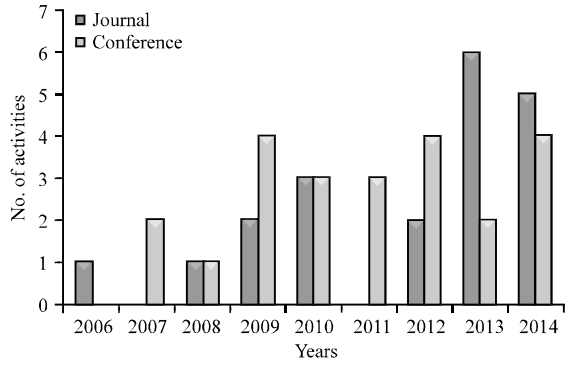

Fig. 2: Research activity per year

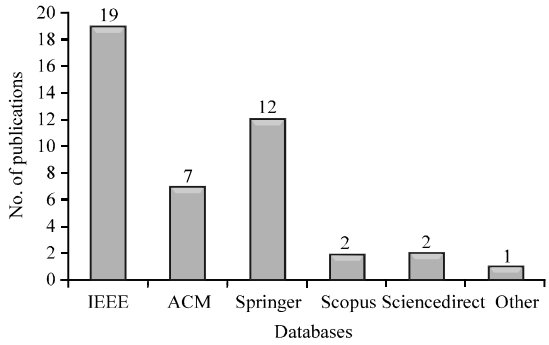

Fig. 3: Publishers of ccselected articles

It shows that Kairos are the most frequently incorporated persuasive strategies in mobile healthcare (Table 1). This indicates that persuasive systems in mobile healthcare highly rely on promoting messages

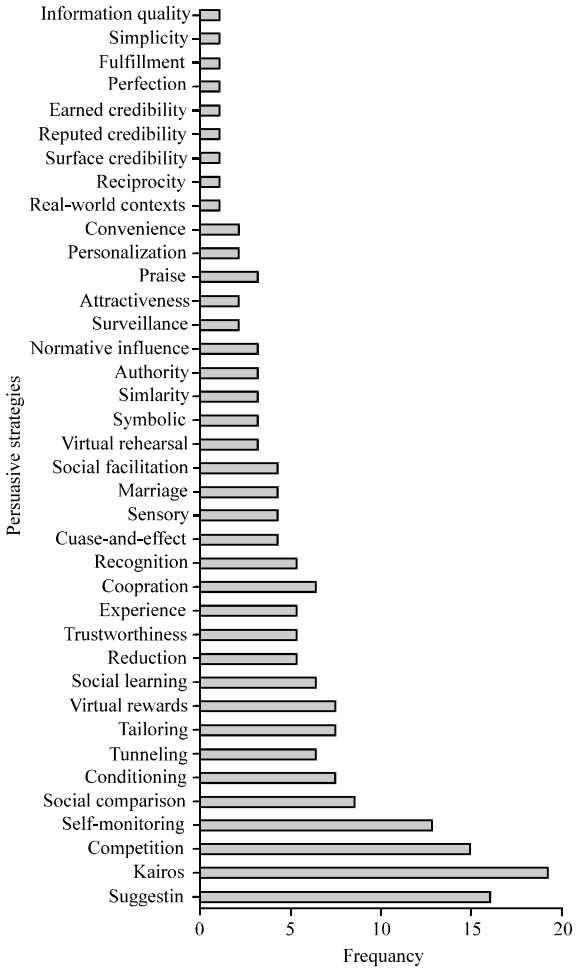

Fig. 4: Frequency of persuasive strategies in mobile health care literatures

to user at an opportune time. Meanwhile, suggestion and competition ranked second and third, respectively and this indicates that leveraging human being's natural drive to provide suggestion or compete is frequently incorporated.

It is also worth noting that all the reviewed strategies were compared with the strategies and concepts by Fogg (2003) as detailed in Table 1. It is seen that most researchers focus on the strategies in tool category more than others. At the same time, the strategies of medium, mobility, social influence and intrinsic motivation categories have received a similar level of attention. In contrast, the strategies in social actor, credibility and computer categories are the least incorporated.

Q2, Q3 Key persuasive strategies in mobile healthcare and their implementation. The analysis also evidences that most researchers adapted the persuasive strategies mainly from two sources: Fogg (2003) and Cialdini

Table 1: Summary of results based on comparison with Fogg's strategies

Main category (sub-category)	Researchers
Tools	
Reduction	Andrew *et al.* (2007), Dewabharata *et al.* (2013) Karppinen *et al.* (2014), Boontarig *et al* (2014) and Mintz (2014)
Tunneling	Andrew *et al.* (2007), Lombardo *et al.* (2010), Dewabharata *et al.* (2013), Karppinen *et al.* (2014), Boontarig *et al.* (2014) and Mintz (2014)
Tailoring	Andrew *et al.* (2007), Yoshii *et al.* (2011), Dewabharata *et al.* (2013), Karppinen *et al.* (2014), Boontarig *et al.* (2014) and Mintz (2014)
Suggestion	Andrew *et al.* (2007), Lombardo *et al.* (2010), Llatas *et al.* (2011), Dewabharata *et al.* (2013), Karppinen *et al.* (2014), Boontarig *et al.* (2014), Mintz (2014), Chen *et al.* (2013), Mukhtar *et al.* (2012), Almomani *et al.* (2014a, b), Lafortuna *et al.* (2014), Klein *et al.* (2014) and Oliveira and Oliver (2008)
Self-monitoring	Andrew *et al.* (2007), Albaina *et al.* (2009), Yoshii *et al.* (2011), Ping *et al.* (2012), Dewabharata *et al.* (2013), Karppinen *et al.* (2014), Boontarig *et al.* (2014), Toscos *et al.* (2006), Chiu *et al.* (2014), Lafortuna *et al.* (2014) and Klein *et al.* (2014)
Surveillance	Mintz (2014) and Dewabharata *et al.* (2013)
Conditioning	Albaina *et al.* (2009), Lombardo *et al.* (2010), Yoshii *et al.* (2011), Ping *et al.* (2012), Dewabharata *et al.* (2013), Mintz (2014) and Halko and Kientz (2010)
Social actor	
Attractiveness	Boontarig *et al.* (2014) and Ismail *et al.* (2012)
Similarity	Andrew *et al.* (2007), Boontarig *et al.* (2014) and Mukhtar *et al.* (2012)
Praise	Ismail *et al.* (2012), Boontarig *et al.* (2014) and Young (2010)
Reciprocity	Andrew *et al.* (2007)
Authority	Mukhtar *et al.* (2012), Halko and Kientz (2010) and Dantzig *et al.* (2013)
Social influence	
Social facilitation	Andrew *et al.* (2007), Lombard *et al.* (2010), Pollak *et al.* (2010) and Karppinen *et al.* (2014)
Social comparison	Andrew *et al.* (2007), Lombard *et al.* (2010), Pollak *et al.* (2010), Mukhtar *et al.* (2012), He *et al.* (2013), Toscos *et al.* (2006), Boontarig *et al.* (2014) and Dantzig *et al.* (2013)
Normative influence	Lombard *et al.* (2010), Pollak *et al.* (2010), Karppinen *et al.* (2014) and Graham *et al.* (2009)
Social learning	Lombard *et al.* (2010), Pollak *et al.* (2010), Andrew *et al.* (2007), Chen *et al.* (2013), Karppinen *et al.* (2014) and Boontarig *et al.* (2014)
Mobility	
Kairos	Andrew *et al.* (2007), Albaina *et al.* (2009), Ahtinen *et al.* (2009), Pollak *et al.* (2014), Mukhtar *et al.* (2012), Chen *et al.* (2013), Karppinen *et al.* (2014), Almonani *et al.* (2014a, b), Mintz (2014), Almomani *et al.* (2014a, b), Dantzig *et al.* (2013), Ahtinen *et al.* (2009), Rodriguez *et al.* (2013), Sohn and Lee (2007) and Oliveira *et al.* (2010)
Convenience	He *et al.* (2013) and Ismail *et al.* (2013)
Simplicity	Ismail *et al.* (2013)
Loyalty	NA
Marriage	Pollak *et al.* (2010), Toscos *et al.* (2006), Almonani *et al.* (2014) and Chen *et al.* (2013)
Information quality	Ismail *et al.* (2012)
Medium	
Cause-and-effect	Andrew *et al.* (2007), Gao *et al.* (2009), Llatas *et al.* (2011) and Ismail *et al.* (2012)
Virtual rehearsal	Albaina *et al.* (2009), Lombardo *et al.* (2010) and Ping *et al.* (2012)
Virtual rewards	Andrew *et al.* (2007), Ping *et al.* (2012), Boontarig *et al.* (2014), Mukhtar *et al.* (2012), Almonani *et al.* (2014a, b), Almomani *et al.* (2014a, b) and Rodriguez *et al.* (2013)
Real-world contexts	Lombardo *et al.* (2010)
Symbolic	Albaina *et al.* (2009) and Ping *et al.* (2012)
Sensory (audio, video)	Andrew *et al.* (2007), Albaina *et al.* (2009), Almonani *et al.* (2014a, b) and Almomani *et al.* (2014a, b)
Credibility and computers	
Trustworthiness	Andrew *et al.* (2007), Albaina *et al.* (2009), Karppinen *et al.* (2014), Boontarig *et al.* (2014), Mintz (2014),
expertise	Andrew *et al.* (2007), Albaina *et al.* (2009), Karppinen *et al.* (2014), Boontarig *et al.* (2014) and Mintz (2014)
Presumed credibility	Mukhtar *et al.* (2012)
Surface credibility	NA
Reputed credibility	NA
Earned credibility	Andrew *et al.* (2007)
Perfection	Andrew *et al.* (2007)
Credibility and web	
Real-world feel	NA
Easy verifiability	NA
Fulfillment	Mukhtar *et al.* (2012)
Ease of use	NA
Personalization	Mukhtar *et al.* (2012) and Toscos *et al.* (2006)
Responsiveness	NA
Intrinsic motivation	
Competition	Andrew *et al.* (2007), Albaina *et al.* (2009), Ahtinen *et al.* (2009), Pollak *et al.* (2010), Mukhtar *et al.* (2012), He *et al.* (2013), Toscos *et al.* (2006), Halko and Kientz (2010), Almomani *et al.* (2014a, b), Almonani *et al.* (2014a, b), Young (2010), Oliveira and Oliver (2008), Oliveira *et al.* (2010) and Sohn and Lee (2007)
Cooperation	Andrew *et al.* (2007), Albaina *et al.* (2009), Ahtinen *et al.* (2009), Pollak *et al.* (2010), Halko and Kientz (2010) and Sohn and Lee (2007)
Recognition	Andrew *et al.* (2007), Albaina *et al.* (2013), Ahtinen *et al.* (2009), Pollak *et al.* (2010) and Halko and Kientz (2010)

* NA: Not Available

(1984). However, some researchers adapted the persuasive strategies from other existing persuasive models such as Fogg Behavior Model (FBM) (Fogg, 2009) and Persuasive System Design (PSD) (Kukkonen and Harjumaa, 2009). As an example, Mukhtar *et al*. (2012) designed a framework for intelligent healthcare self-management by incorporating persuasive strategies from FBM (Fogg, 2003). Besides that, most of the strategies were adapted from Fogg (2009) and Cialdini (1984). However, they do not explain how they classify the strategies.

On the other hand, one notable development of software architecture has been clearly seen in the research by Alahaivala *et al*. (2013). This architecture fully depends on the analysis of the persuasiveness context from the PSD Model (Kukkonen and Harjumaa, 2009) in which it was developed. However, this architecture has not been tested in the real world with actual data from users and also it is yet to be measured in order to be evaluated. Moreover, there is no expert evidence (expert view) that ensures the implementation of the mentioned architecture is correct. According to Kegel and Wieringa (2014), despite the PSD Model may become useful in motivating and persuading users to reach their personal goals, the way researchers adapted the principles of persuasion from Fogg has not been explained. In other words, no explicit reasoning was given for their selection of the techniques. In fact, the principles have not been implemented in real-world projects.

Otherwise, other researchers also adapted persuasive strategies from theories that emphasize on changing of behavior. As an instance, Ahtinen *et al*. (2009) have studied the concepts of persuasiveness in their research to understand how user's usage of mobile applications can change their lifestyle to better wellness. Their research is based on two cognitive theories namely, Cognitive Behavior Therapy (CBT) and Transtheoretical Model (TTM) from (Prochaska and Norcross, 2001) that are related to persuasion. However, the researchers have not explained which strategies are incorporated into the mobile wellness applications and how they are being implemented to persuade users.

In the same way, Beun (2013) develops a virtual mobile coach that functions as the first intervention for insomnia treatment. Beun (2013) also adapted the strategies from CBT. In the series, Consolvo *et al*. (2009) develop a persuasive system based on goal-setting theory, followed with Ping *et al*. (2012) and Chang *et al*. (2012) who implement the goal-setting partially.

Additionally, it is also worth noting that some new persuasive strategies appear in the reviewed literatures such as achievement, narrative, reputation and social validation. Most of these strategies convey similar concept with Fogg (2003)'s and Cialdini (1984). In addition, the terminology "strategies" is used in the literatures with different names such as "principles", "features", "techniques" or "elements" in which the details can be observed in Table 2.

Table 2: Comparison of original and new strategies

Original strategy (Fogg, 2003)	New strategies
Fulfillment	Achievement (Mukhtar *et al*., 2012)
Social comparison	Narrative (Mukhtar *et al*., 2012)
	Social validation (Toscos *et al*., 2006)
Reputed credibility	Reputation (Mukhtar *et al*., 2012)

One of the key points being highlighted several times in the literatures is the evaluation of the persuasive systems. Most of the developed systems have been evaluated with a small sample of users for a short-term. In addition, most researchers focus on the acceptance of the technology rather than persuasion in the evaluation process. However, they suggested in conducting studies related to persuasive strategies alone in the future research.

CONCLUSION

This study argues that the existing researchs emphasize on a few persuasive techniques without describing how they are integrated into the software systems in the domain of mobile healthcare. Additionally, most of the researchers did not follow systematic processes during the design phase of the persuasive technology applications as well as they have failed to provide some of the relevant information needed in designing persuasive applications. Consequently, most of the researchers and designers have guessed solutions to change behavior. Moreover, the expert evaluation has not yet been conducted on the implemented persuasive features. In the end, the greatest challenge in the review is how to design persuasive software that can change user's behavior in order to achieve their goals. Therefore, there is a need of an extensive research in the future where the practical categorization of persuasive principles for mobile healthcare be developed and evaluated. As well as proposed a generalizable persuasive software architecture to be used as a reference for the practitioners to develop mobile healthcare applications that can change behavior among users.

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