Persuasive Technology and Mobile Healthcare: A Critical Review

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Persuasive Technology and Mobile Healthcare: A Critical Review

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Abstract---Recent advances in persuasive technology are topics of great interest in the design of mobile healthcare applications. Persuasive technology emphasizes on how to change the behavior or attitudes of individuals. Right now, persuasive components are gradually implemented into the design of the mobile healthcare applications. However, identified gaps include scarcity of studies on how persuasive components are integrated in that domain; limited studies on how to transform the persuasive technology into software requirements and functionalities for designing mobile applications; majority of previous studies did not follow any of systematic processes related to the software architecture for analysis and design of persuasive technology systems. This led to the lack of required design details that should be provided by designers. In light of those major gaps, this paper argues that an extensive critical review based on the key question on how persuasive applications should be designed in ensuring that the system interacts with individuals in changing their behaviors or attitudes. This paper argues that previous studies did not highlight how technologies such as persuasive features are integrated into the system design particularly in healthcare domain. As a conclusion, this paper suggests that a set of guidelines for the adoption and integration of persuasive features in mobile healthcare and architecture is highly needed, and to do broaden researchers for future works.

Index Terms---Mobile healthcare, Mobile Architecture, Behavior Change, Persuasive technology, Persuasive strategies, Persuasive principles, Persuasive models, Human-computer interaction

I. Introduction

Mobile healthcare (m-healthcare) applications are increasingly becoming an integral part of the daily life of individuals because of their potential benefits that impacted the users in changing their behavior [1], and [2]. Healthcare assessed through the m-healthcare system is regarded as a solution to address the high cost of healthcare and maintaining the status of the treatment overtime [3], and [4]. The progressive shift in m-healthcare appears promising in supporting people to adhere to their health goals [5]. One of the techniques of behavior change in the healthcare field is the persuasive technology that can be used as a practical measure to ensure effectiveness of health solutions [6]. Persuasive technology in the form of m-healthcare applications has the potential to promote health benefits, however, in the literature these technologies are still unclear on how they should be integrated into mobile applications [7], and mobile architecture [8], and [9].

In this context, previous researchers have attempted to design or propose solutions such as architecture, model, or framework as guidelines in this domain to persuading users in changing their behaviors [10], [11], and [8]. However, most of the researchers faced difficulties in integrating persuasive components due to the vague support in the literatures [7], and [12]. Adding to this is the scarcity of studies on persuasive m-healthcare architecture [10], [11], [8], and [9] . Moreover, the most available studies were also not carried out based on a systematic process of software architecture for the analysis and design of the persuasive applications [13], and [14]. Nevertheless, some of the studies tried to interpret the persuasive components in designing and evaluating the persuasiveness of the software system. As such, a study is needed in transforming the persuasive technology into software requirements and functionalities for the design of mobile software architecture, particularly for m-healthcare.

Within the above context, the main contribution of this paper is the review of the persuasive technologies in m-healthcare and their integration. In addition, analysis of relevant literature on persuasive components is also included. For that purpose, the review will answer the following questions:

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i. What is the research activity level for persuasive technologies in m-healthcare?

ii. What are the fundamental persuasive components that influence the individuals in m-healthcare?

iii. How the current persuasive components are integrated in m-healthcare?

The review is regarded as an initial step in clarifying the literatures on persuasive components for m-healthcare in order to develop a practical categorization particularly in supporting the design of persuasive m-healthcare software architecture and its implementation.

II. Origin of Persuasive Technology

The sphere of persuasive technology that is specifically designed to impact on the way of life or actions has been introduced by Professor B.J. Fogg of Stanford University in 1996. It is famously referred to as captology, a term from Computers as Persuasive Technology [15]. Briefly, captology is a study of options and problems linked to the application of computers for persuasive purposes. The original definition of persuasive technology by [16], is an attempt to motivate and alter people's attitude or behavior to use the technology through persuasion, but must be without coercion or fraud. The idea about persuasion is sometimes made of possibilities of views, it is an attempt to remodel, strengthen, or change the way of thinking, judgment, or views about an issue, entity, or action.

From psychology and communication perspectives, the persuasion refers to the efforts in guiding individuals to adopt some actions, convictions, or a position chosen by the individuals through reasoning [17]. In most cases, people are naturally protective of their views and their behaviors and can close their minds to change if persuasion is not addressed in an acceptable fashion. According to [18], persuasion is effective when the goals change the attitudes and beliefs or behavior as desired. Additionally, [19] addresses that persuasion is a "human communication designed to influence the autonomous judgments and actions of others".

It is seen that the definitions in the previous paragraphs emphasize on communication. According to [16], with regard to communication, human-computer interaction can also be persuasive besides human communication. As an illustration, interactive technologies including mobile devices, tablet PCs, video games, internet services, and social networks generate options for persuasive contact because individuals can access them pervasively. In fact, the field of persuasive technology is rapidly growing [20].

In accordance, persuasive technology has been absorbed into various domains in our daily life including education [21], and [22], safety [23], and health [24]. Theoretically, the major potential of persuasive technology lies in its ability to help people to promote the desired targets in life. In healthcare, it acts as a persuasive mechanism in promoting wellness among communities to improve their quality of life by educating, tracking, and maintaining their health.

III. Six Principles of Cialdini

Cialdini was the first to outline the strategies of influence. In his book, "Influence: The Psychology of Persuasion", he addresses six principles of persuasion or influence [25], that include: (i) Commitment and Consistency: If individuals have decided to implement a goal or commitment, they are likely to pledge their commitment to the idea or objective as being similar to their personality. Even if the initial motive is removed, individuals are likely to continue with this obligation. (ii) Authority: Individuals tend to obey verified facts, even if they are required to carry out objective actions. (iii) Reciprocity: People are more likely to accede to a favor of any size if it is preceded by a small gift or favor. (iv) Liking: People are more likely to be easily persuaded by other people they like. (v) Scarcity: Apparent shortage will bring about demand. An illustration is offers made available for "a short time only", resulting in sales. (vi) Societal Social Attestation (Consensus): Individuals will do things they observe in other people's actions. These principles are general and can be used for any type of persuasion, although Cialdini focuses on human-human interaction, without considering HCI or how technologies can act as a tool to persuade individuals to change their behaviors. The literature reveals that studies have adapted Cialdini's principles and concepts in the design of HCI systems [26], and [27]. Meanwhile, Fogg [6], the guru of persuasive technology offered a holistic set of persuasive strategies through his published book "Persuasive Technology: Using Computers to Change What We Think and Do". The holistic strategies can increase users' motivation and ability to change their way of thinking or behavior and make them better in achieving the desired outcome [6]. In short, the adapted persuasion strategies in the design have often based on the researcher's own intuition. This makes it difficult to provide a generalize result to solve various problems.

IV. Persuasive Models

Literatures reveal a few persuasive models incorporated into persuasive computing systems which are used in categorizing the persuasive components. The main models are described as follows.

A. Fogg Behavior Model (FBM)

In this model, the three key factors that drive the human behavior include; ability, motivation and trigger [28], as illustrated in Figure 1. These factors control the behavior being performed. The motivation and ability factors can be seen as complementary. The target behavior is more likely to happen with high motivation and high ability. However, when ability is low, increasing the motivation will increase the likelihood for the target behavior. Vice versa, low motivation can be compensated by high ability. Based on the model, motivation can be increased by increasing pleasure, hope or social acceptance or decreasing pain, fear or rejection. Meanwhile, ability can be increased by simplicity whereby simplicity is made up of six elements that include; (i) time, (ii) money, (iii) physical effort, (iv) brain cycles, (v) social deviance, and (vi) non-routine. All of the elements have to function properly for simplicity to be simple, meaning that decreasing an element increases simplicity and increases the ability.

Behavior is still unlikely to happen, though both ability and motivation are high due to the missing of trigger. The trigger is effective when motivation and ability are above certain levels. If the trigger is below this level, it produces undesirable effects and can cause disappointment. There are three types of trigger namely; (i) spark - this trigger has a motivation element in it, (ii) facilitator - this trigger is suitable for users with high motivation but less ability, and (iii) signal - this trigger does not try to motivate or simplify tasks.

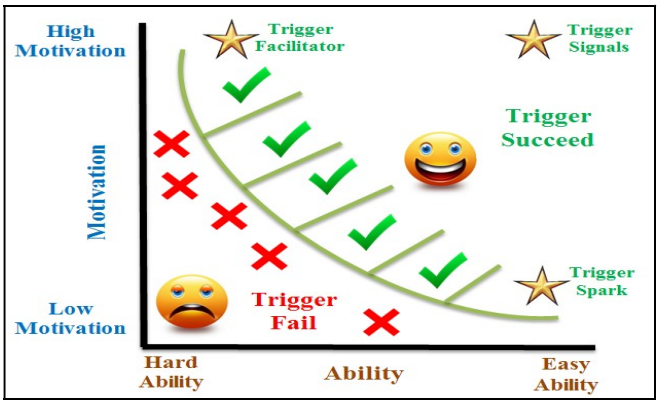

Figure 1. Fogg behavior model modified from [28]

The Fogg behavioral model has the utility of being concise, easy to understand, and pretty robust. It also helps academics understand behavior change better [29]. In sum, it also can be applied in changing user's behavior using mobile technology as a channel for triggering the required behavior. Through FBM, designers and researchers can systematically think about the factors that underlie the behavioral change [28], and [30]. In other words, FBM can be used to identify obstacles that inhibit people from performing a specific behavior. Finally, the FBM is advisable to implement in evaluating behavior change systems that work based on the persuasive design strategies [31].

B. Persuasive Systems Design (PSD)

PSD is a model introduced by [32] where it provides methodical study and proposes a method for mounting persuasive software solutions. The model shows seven basic postulates utilizing persuasive systems and how to study the background of persuasion. It also explains the functions of the content and software in the output. Further, it lists 28 design principles for persuasive system content and functionality. The new category of these principles includes; the primary task, dialogue, system credibility, and social support as shown in Figure 2, which is adapted from Fogg [6].

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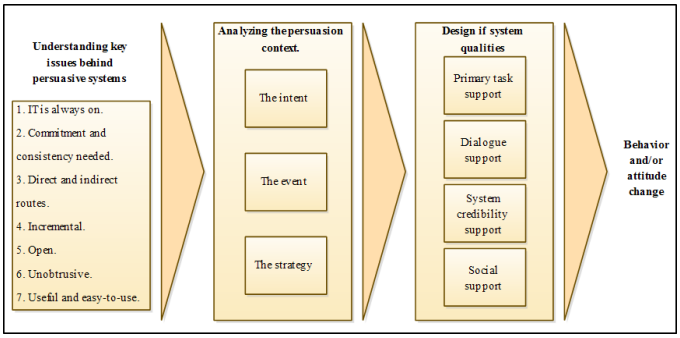

Figure 2. Persuasive Systems Design [32]

Although the PSD model has been used to motivate and persuade users to achieve their personal goals, researchers did not explain the way of adapting the principles of persuasion from Fogg [6]. In other words, no explicit reasoning was given for their selection of the techniques [26], and [7]. In fact, the principles have not been implemented in real-world projects. In other words, no explicit reasoning was given for their selection of the techniques [26], and [7]. PSD method seems to have potential in guiding the development of the persuasive systems for behavior change. So far they have been tested in only relatively small trials. In addition, some of the criteria previously studied by [32] were not verified in terms of relevance and criteria efficiency through experimental methods [33]. Most recent works using PSD models in persuasive designs are still at conceptual level [34], and [35]. This model does not guide the designer thoroughly to implement the proposed design activity as it is too generic [36] The main gap observed in [32] is just discussion of the persuasion context, but it fails to deliver the specifics about how to analyze a domain or system and extract the necessary elements to build a persuasive context [37]. No toolkit for systems analysis is suggested to accompany the PSD. Until now, most PSD principles are not evaluated in real-world projects such as persuasive mobile architecture [38]. This is due to insufficient information to guide the designer in performing the activities in the PSD model [39].

C. The Transtheoretical Model (TTM)

This biopsychosocial model, also called the stages of change model as shown in Figure 3, was developed by Prochaska and DiClemente [40]. It considers the health behavioral change as part of a sequential process that occurs through six stages, as follows. (i) pre-contemplation is the first stage in the model, where the users have not yet considered changing their behavior. They are unaware that their behavior is problematic or has negative repercussions. This means they have no motivation. (ii) Contemplation: the individual intends to start to change certain behavior, and is beginning to recognize that their behavior will be problematic in the foreseeable future. Even with this admission, individuals maybe still feel hesitant about changing their behavior. (iii) Preparation, or determination: here individuals are fully intending to take action to change their behavior. This means they have plans to start taking the small steps toward the behavior change. They have been thinking about it for the long duration of time, and they that changing their behavior may give rise to a healthful life. (iv) Action: the individuals at this stage have actually changed their behavior, and are maintaining it by modifying obstacles. They may intend to keep up the new behavior for six consecutive months, to get primary results to measure the change in acquiring new healthy behaviors. (v) Maintenance: at this stage people must be maintaining their behavior change and avoid relapse to earlier stages. For example, the individuals work to be able to continue and keeping on changing their behavior for six months without a relapse. However, some of them do not apply the change processes as regularly as like other individuals. (vi) Termination: individuals are unwilling to return to their unhealthy behaviors. They must have 100% self-efficacy, and be sure not too relapsed. This stage is considered a challenge in coping with unhealthy habits, and most individuals tend to stay at the maintenance stage without going forward to this stage.

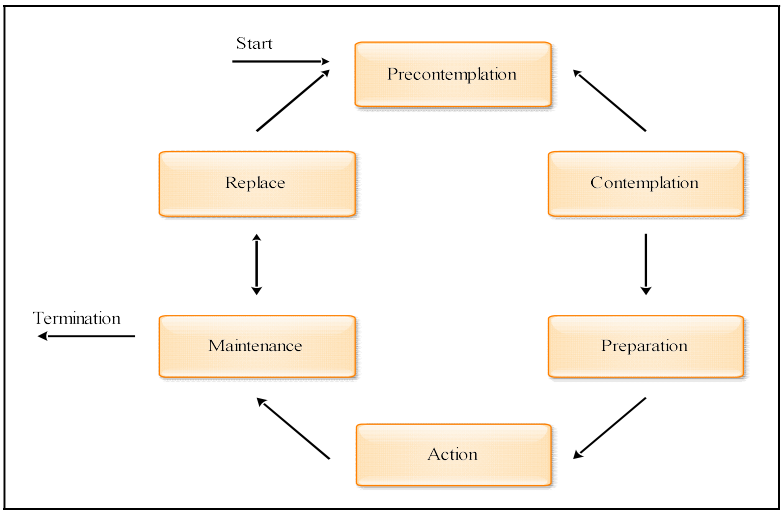

Figure **Error! No text of specified style in document.**. The Stages of Change Model [40]

Although the transtheoretical model of change is widely used in health behavioral change, it has been strongly criticized [41], and [42]. In that regards, Fogg and his colleagues [43] stressed that its first three stages of TTM are not types of behavior, but stages that anticipate behavior.

In sum, this model does not indicate how and when the individual can remain at each stage. Therefore, it is considered complex and unclear, with an absence of actionable recommendations. Although it is widely used in human-human persuasion because of its ability to cope with changes in individual behavior interventions, this feature is not readily available in PT approaches. Consequently, the practitioners are finding it difficult to imitate and apply the stages of TTM in practice work based on human-computer persuasion.

V. Eight-step Design Process of Persuasive Technology

Fogg [44] proposed eight steps to be followed as top practices in the initial stages of persuasive technology design. The processes are derived from demonstrated successes in the industry. With the first step is clarifying the persuasion goal, which is the required behavior that aims to match a target audience with a suitable technology channel. Subsequent steps include imitating the successful instances of persuasive design, performing rapid trials, measuring behavioral outcomes, and building on small successes. Figure 4 depicts the eight steps of the process.

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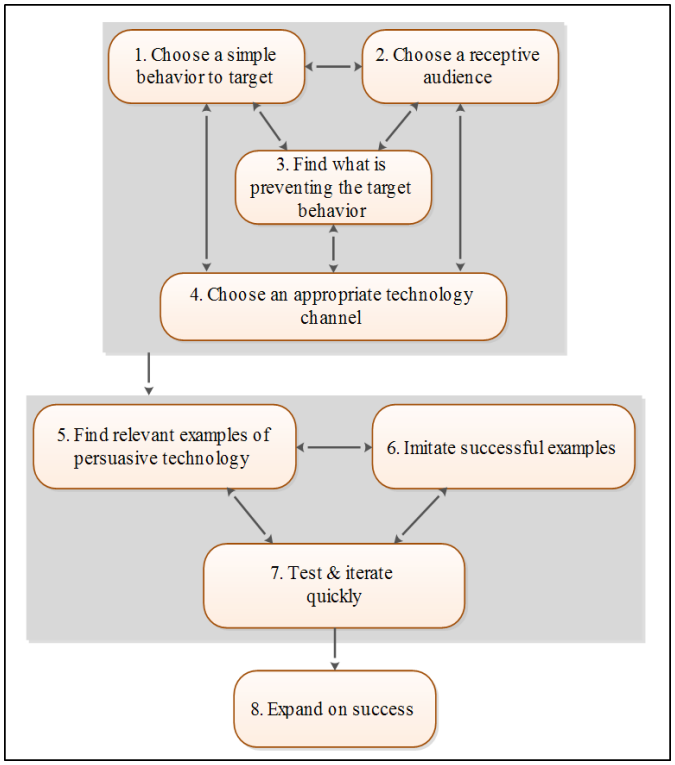

Figure **Error! No text of specified style in document.**. Eight-step process [44]

This seems to be the most influential in supporting systematic behavior change interventions strategies, however, how each of these principles or strategies be implemented in a particular user context is not clear [45]. An explicit user model is needed in order to implement these strategies and to get more insights into the mechanisms of their working. However, it offers a good way to think that persuasiveness is important in persuading individuals through applications to adopt desired behaviors.

VI. Persuasive Behavior Wizard

Fogg & Hreha [43] introduced the Behavior Wizard, a method of users' behavior change when dealing with studies related to the design of persuasive technologies. It provides 15 ways of behavior change as shown in Figure 5. The aim of this method is to match the type of target behavior with solutions for achieving those targeted behavior. A three-phase process will be used for the wizard. Based on these phases, the designers have to: (i) identify the target behavior, (ii) identify the triggers, and (iii) develop a plan to implement the targeted behavior strategies. The horizontal axis parts of the wizard behavior classified into five "Flavors" which uses five different colors to represent five different behaviors. Therefore the designers have to decide based on the wizard whether the behavior is new that is unfamiliar (Green), familiar behavior (Blue), wish to increase (Purple) or decrease (Gray) in intensity, or need to stop (Black). The behavior is either new or normal based on the individual being the target of persuasion. For example, it is a new experience for most people to do exercise every morning, but not to those who used to do it. In applying the method, it is important for the designers to understand the target audience. The vertical axis represents behavior's durations, where the designers have to identify the type of target behavior as suggested by Fogg and Hreha [43] that include; one time (Dot), period of time (Span) and from now on (Path). In the second phase, the designers have to identify the triggers of the behavior whereby a trigger is something that attracts the user to perform the target behavior. A trigger is considered "cyclic" when it happens at regular intervals such as taking antibiotics for three weeks or taking multivitamins every day for a month. In the third phase, the classification of persuasive strategies, models, or any proposed solutions for the behavior type based on the purpose of the system and the users.

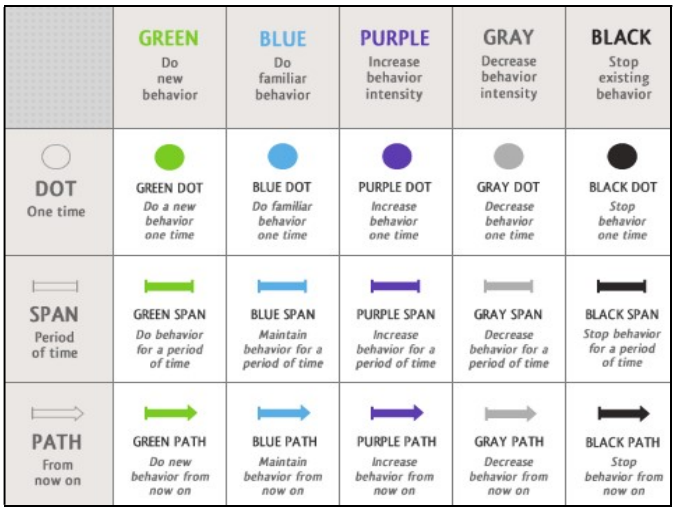

Figure **Error! No text of specified style in document.**. Behavior Wizard from [43]

This method is more rich and concise as it summarizes the findings in psychology and behavior change field in fifteen cells matrix of behavior and change types [46]. In the past, behavioral psychology researchers and mobile app designers had to make guesses at solutions for changing behavior. However, most of their attempts failed. The Behavior Wizard developed by Fogg and Hreha [43] is useful as a guide to provide a solution for designers in identifying the type of behavior change used for persuading individuals. With these 15 types of behaviors, it can isolate, identify and clarify the target behavior and distinguish it from others and help to create a persuasive experience [43]. They also indicated that the researchers should focus on a type of change and not all of them. Therefore, Fogg and Hreha [43] provide examples of the techniques that can be used to achieve the desired behavior depending on the type of behavior change. It is obvious that these guides are valuable guide for designers; however, their major emphasis is on intended user behavior and designers' intentions [47].

VII. Methods

This paper begins by addressing its aims at reviewing the key persuasive components in m-healthcare and its implementation. In achieving that, a structured research methodology was conducted and adapted from [48], and [49] consisting of two phases. The first phase involves search and selection of the articles while the second phase involves the classification and analysis of the articles.

The first phase explores the popular academic publishers namely; IEEE, ACM, and Springer. In this phase, 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"). All these search terms for articles are 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, all the articles related only to the key questions in the domain of m-healthcare were selected. The articles include journals and conference proceedings that were published in English only.

In the second phase, a well-defined taxonomy was created to enable the classification and analysis of the selected articles to be carried out. The content of the taxonomy is dependent on the review questions. In addition, all selected articles were based on analysis and reading of the full text. For the purpose of classifying and analyzing the selected articles, various approaches were used. One of these approaches is to classify system for reliability as well as topics that also include relevant data of a search [50]. In addition, content analysis using a constant comparative method was employed [51]. Furthermore, this phase also exclude articles which do not meet the selection criteria that include; editorials, prefaces, article summaries, interviews, news, reviews, correspondence, discussions, comments, reader's letters and summaries of tutorials, workshops, panels, and poster sessions. In the following section, the results of the selection and analysis are discussed in detail.

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VIII. Result

This section describes in detail the selected most of literary works based on the questions of this study.

A. Level of research activity of persuasive technologies in m-healthcare

In general, 457 articles were selected for analysis based on keywords and databases. All the works are reported in articles published in persuasive technology in mobile healthcare domain. Figure 6 illustrates the proportion of papers from the sources which include IEEE, ACM, ScienceDirect, Scopus, Springer, and others.

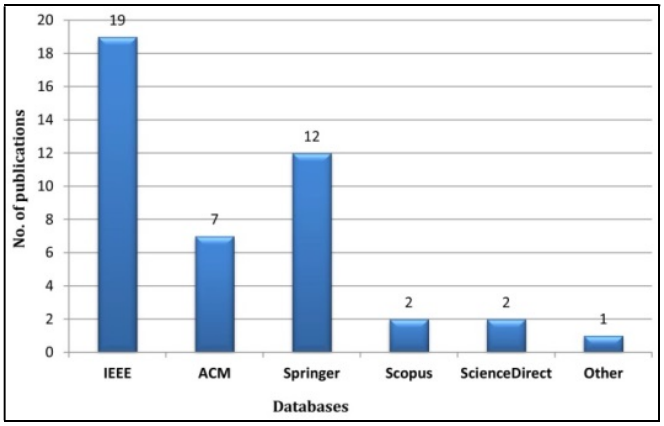

Figure 6. Publishers of selected articles

In this review only 43 articles were related to the persuasive components and mobile software architecture. Meanwhile, 3 out of 43 articles discussed only the concept of persuasive technology without any explanatory data [12], [52], and [53]. Adding to that, 6 articles discussed only the persuasive components without any clear explanation such as [54], [55], [56], [57], [58], and [59]. It was found that most researchers explicitly adapted the persuasive components from one of the identified sources.

Based on the articles, research activity of persuasive components in mobile healthcare has commenced effectively since 2006. Since then, the interest in the research area has increases steadily as shown in Figure 7.

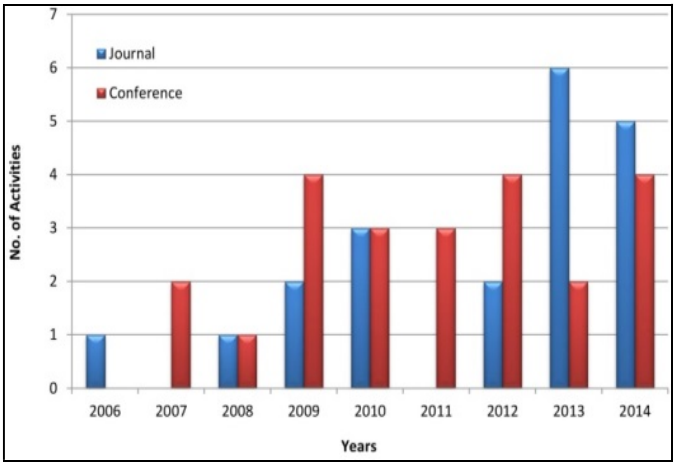

Figure 7. Research Activity per Year

In the analysis phase, the frequency which refers to the number of persuasive strategies in m-healthcare as appeared in the literatures is stated. Figure 4 illustrates the frequency of persuasive components in m-healthcare literatures.

In this review, Figure 8 shows that the Suggestion and Kairos are the most frequently implemented components in the m-healthcare applications. It indicates that persuasive applications in healthcare domain highly rely on promoting persuasive messages to users at an opportune time. Likewise, competition component which represents leveraging human beings' natural drive to compete and it is often implemented in the general health applications.

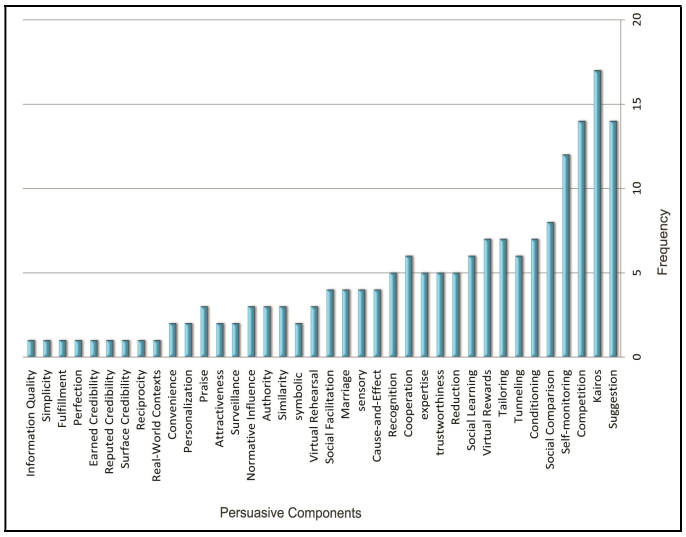

Figure 8. The frequency of persuasive components in m-healthcare literatures

B. Fundamental persuasive components and their integration in m-healthcare

Based on the analysis phase, most of the investigators in this domain referred to [6], and [25] in designing the persuasive components. Meanwhile, the persuasive components have been adapted from other existing persuasive models such as FBM [28] and Persuasive System Design [7]. For instance, [11] designed an architecture that combines the persuasive benefits of ubiquitous and social computing to help patients and caregivers' healthcare management. They considered diabetes self-management as a case study. They used several persuasive components based on motivation, ability and trigger of FBM as well as some persuasive components from the theory of Cialdini [25]. Nonetheless, the researchers did not elaborate on the integration and implementation of the persuasive components in their study.

Furthermore, one notable study in software architecture design was clearly observed in the work of [10]. They have designed a software architecture based on the analysis of the persuasiveness context from the persuasive systems design model [32]. Nevertheless, this study has yet to measure and evaluate in the real world with actual individuals. This means that there is no agreement on how to measure the level of persuasion of users especially for behavior change systems targeting specific problem [60], and [61]. So far, no expert review (expert judgments) has verified that the implementation of the mentioned persuasive instruments [41] and software architecture is correct [10], and [38].

Additionally, [62] propose eMotiva architecture to detect behavior series of subjects in nursing homes. They incorporated two implicit strategies; suggestion and cause-and-effect. In this study, they presented a conceptual work to help patients with dementia via discovering conduct disorders in the nursing homes. However, their proposed software architecture has not been implemented in real life with real users.

Also, [63] proposed an architecture that combines home sensors and wearable sensors to help elderly to receive weekly SMS with emails or cell phone. This work is focused on the set of persuasive sensing to help patients to self-managing diabetes. The sensors work with computers and cell phone as persuasive tools for monitoring patients to manage their disease every day. However, it has not been focused on software architecture but on hardware devices to send data to a cell phone through short message service.

On the other hand, [55] evaluate the components of twelve applications based on using a persuasive system design model. The results show that of the four categories in the PSD model, the components in the primary task support were the most common ones, whereas the strategies in the social support category were the least. The researchers did not mention on how they validate the persuasive components in the applications based on the PSD model.

According to [7], the PSD model maybe helpful in motivating and persuading users to reach their personal aims. They also adapted the principles of persuasion from Fogg's theory. However, they give no explicit logic to the components of persuasive to be integrated in the design. Indeed, those principles were not being implemented in the real software architecture.

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Otherwise, some of the researchers also adapted persuasive principles from theories that assert on the behavior change. For example, [64] adapt Cognitive Behavior Therapy (CBT) and TTM in the implementation of the persuasive components. In the same view, [54] developed a virtual mobile coach that functions as the first intervention for insomnia treatment and also adapted the strategies from CBT. In the series, [35] developed a persuasive system based on goal-setting theory, followed with [65] who implemented the goal-setting partially. However, they did not explain the components that are integrated into the design of the m-healthcare applications and how they are being transformed into persuasive components for mobile platform.

On a related note, one of the important points that have been highlighted in the literatures is how the persuasive mobile applications are evaluated. In this context, most researchers have evaluated the applications with a small sample of individuals. Additionally, in the evaluation process, majority of researchers focused on the acceptance of the technology rather than persuasion. However, for future research, they suggested in conducting studies on persuasive strategies alone.

Based on this review, some new persuasive components such as achievement, narrative, reputation, and social validation have been observed from previous studies. However, these components convey similar concept with [6], and [25].

IX. Limitations

This review analyzed the last 14 years of literatures involving PT in mobile apps for healthcare domain. The research started from 2000 until end of 2014. The field of mobile apps with PT is relatively recent. Thus, the first paper was shown in 2006. The studies that only were published in English were analyzed. In this review might be missed some studies because of the search criteria and search terms that we used. A further investigation through systematic literature review will be performed in the future.

X. Conclusion

In conclusion, this paper discusses the existing works on persuasive technology and m-healthcare where the contributions are helpful for researchers in constructing new persuasive mobile architecture in their future works. Indeed, this review has identified lack of how the persuasive components are integrated into m-healthcare. Moreover, it has been found that most of the researchers did not follow systematic process at the design stage of persuasive mobile application. They also failed to offer proper guidelines in designing software architecture. Another key point is that this review reveals that there is a need to incorporate persuasive components in m-healthcare architecture to target for specific problem. Adding to that, expert evaluation so far has not yet been conducted on any implemented persuasive components in designing software architecture and persuasive instrument. In conclusion, there is a need of an extensive research in the future to develop and evaluate persuasive guidelines for m-healthcare and mobile architecture.

XI. Acknowledgement

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References

[1] A. Ariani, A. P. Koesoema, and S. Soegijoko, "Innovative Healthcare Applications of ICT for Developing Countries," in Innovative Healthcare Systems for the 21st Century: Springer, 2017, pp. 15-70.

[2] S. H.-M. Guo, H.-K. Chang, and C.-Y. Lin, "Impact of Mobile Diabetes Self-Care System on patients' knowledge, behavior and efficacy," Computers in Industry, vol. 69, pp. 22-29, 2015.

[3] W. S. Ng, J. C. M. Teo, W. T. Ang, S. Viswanathan, and C. K. Tham, "Experiences on developing SOA based mobile healthcare services," presented at the IEEE Asia-Pacific Services Computing Conference, APSCC 2009.

[4] M. Price, D. Williamson, R. McCandless, M. Mueller, M. Gregoski, B. Brunner-Jackson, E. Treiber, L. Davidson, and F. Treiber, "Hispanic migrant farm workers' attitudes toward mobile phone-based telehealth for management of chronic health conditions," Journal of medical Internet research, vol. 15, 2013.

[5] S. Carrino, M. Caon, O. A. Khaled, G. Andreoni, and E. Mugellini, "Pegaso: Towards a life companion," presented at the International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management, 2014.

[6] B. J. Fogg, "Persuasive technology: using computers to change what we think and do," San Francisco: Morgan Kaufmann Publishers, 2003.
[7] R. H. Kegel and R. J. Wieringa, "Persuasive technologies: a systematic literature review and application to PISA," 2014.
[8] M. Oduor, T. Alahäivälä and H. Oinas-Kukkonen, "Persuasive software design patterns for social influence," Personal and ubiquitous computing, vol. 18, pp. 1689-1704, 2014.
[9] M. Oduor, T. Alahäivälä, and H. Oinas-Kukkonen, "Software Design Patterns for Persuasive Computer–Human Dialogue: Reminder, Reward, and Instant Feedback," Behavior Change Research and Theory: Psychological and Technological Perspectives, p. 47, 2016.
[10] T. Alahäivälä H. Oinas-Kukkonen, and T. Jokelainen, "Software architecture design for health BCSS: case onnikka," presented at International Conference on Persuasive Technology, 2013.
[11] H. Mukhtar, A. Ali, S. Lee, and D. Belaïd, "Personalized healthcare self-management using social persuasion," Impact Analysis of Solutions for Chronic Disease Prevention and Management, pp. 66-73, 2012.
[12] T. Lehto, H. Oinas-Kukkonen, T. Pätiälä, and O. Saarelma, "Virtual health coaching for consumers: a persuasive systems design perspective," International Journal of Networking and Virtual Organisations, vol. 13, pp. 24-41, 2013.
[13] I. Wiafe, "U-FADE: A Unified Approach to Persuasive Systems Development," International Journal of Conceptual Structures and Smart Applications (IJCSSA), vol. 1, pp. 6-16, 2013.
[14] H. Mukhtar, "Towards analytical modeling for persuasive design choices in mobile apps," International Journal of Advanced Computer Science and Applications, vol. 7, pp. 428-434, 2016.
[15] B. J. Fogg, "Persuasive computers: perspectives and research directions," presented at the SIGCHI conference on Human factors in computing systems, 1998, pp. 225-232.
[16] B. J. Fogg, "Prominence-interpretation theory: Explaining how people assess credibility online," presented at the CHI'03 extended abstracts on human factors in computing systems, 2003, pp. 722-723.
[17] K. K. Reardon and G. T. Fairhurst, Persuasion: Theory and context. London: Sage Publications, 1981.
[18] P. Briñol and R. E. Petty, "Persuasion: Insights from the self-validation hypothesis," Advances in experimental social psychology, vol. 41, pp. 69-118, 2009.
[19] S. Chapman, "Advocacy in public health: roles and challenges," International Journal of Epidemiology, vol. 30, pp. 1226-1232, 2001.
[20] J. Sturm, “Persuasive Technology,” in Handbook of Smart Homes, Health Care and Well-Being. J. van Hoof, G. Demiris & E. J. M. Wouters, Eds.: Springer International Publishing, 2014.
[21] M. F. Yusoff, A. N. Zulkifli, and N. F. Faisal Mohamed, "The Model of Persuasive Hajj Learning Environment," Jurnal Teknologi, vol. 77, pp. 141-147, 2015.
[22] A. N. Zulkifli, M. Ahmad, J. A. Abu Bakar, R. Che Mat, and N. Noor, "Interactive persuasive learning elements among elderly: A measurement model," Jurnal Teknologi, vol. 77, pp. 145-153, 2015.
[23] L. Chittaro, " Passengers’ Safety in Aircraft Evacuations: Employing Serious Games to Educate and Persuade," in Persuasive Technology. Design for Health and Safety. PERSUASIVE 2012. Lecture Notes in Computer Science, vol. 7284, M. Bang and E. L. Ragnemalm, Eds.: Springer, 2012.
[24] S. Chatterjee, S. Chakraborty, S. Sarker, S. Sarker, and F. Y. Lau, "Examining the success factors for mobile work in healthcare: a deductive study," Decision Support Systems, vol. 46, pp. 620-633, 2009.
[25] R. B. Cialdini, Influence: The Psychology of Persuasion. New York: Harper Collins, 1984.
[26] S. Dantzig, G. Geleijnse, and A. T. Halteren, "Toward a persuasive mobile application to reduce sedentary behavior," Personal and ubiquitous computing, vol. 17, pp. 1237-1246, 2013.
[27] T. Toscos, A. Faber, S. An, and M. P. Gandhi, "Chick clique: persuasive technology to motivate teenage girls to exercise," presented at the CHI'06 extended abstracts on Human factors in computing systems, 2006, pp. 1873-1878.
[28] B. J. Fogg, "A behavior model for persuasive design," presented at the 4th international Conference on Persuasive Technology, 2009.
[29] W. H. Chou, T. Chang, C.-S. Hwang, C.-W. Hung, Y.-H. Shiau, and Y.-L. Ko, "Persuasive technologies with Gamification: Change the campus with fun," National Yunlin University of Science & Technology, Doliu, Taiwan, 2013.
[30] M.-H. Tsai, Y.-L. Chang, C. Kao, and S.-C. Kang, "The effectiveness of a flood protection computer game for disaster education," Visualization in Engineering, vol. 3, p. 9, 2015.
[31] C. Kouroupetroglou, M. Piso, W. Derguech, E. Curry, J. Mink, D. R. Recupero, et al., "Engaging users in tracking their water usage behavior," Procedia Engineering, vol. 119, pp. 788-797, 2015.

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[32] H. Oinas-Kukkonen and M. Harjumaa, "Persuasive systems design: Key issues, process model, and system features," Communications of the Association for Information Systems, vol. 24, pp. 28, 2009.

[33] A. Némery and E. Brangier, "Set of guidelines for persuasive interfaces: organization and validation of the criteria," Journal of Usability Studies, vol. 9, pp. 105-128, 2014.

[34] K. Yu and H. Li, "Mechanism of Persuasive Experience-A New Design and Evaluation Framework of Persuasive Systems," presented at the International Conference of Design, User Experience, and Usability, 2016, pp. 132-143.

[35] F. Kasali, K. Afolashade, and A. Oludele, "Systematic Review of Persuasive Health Technology Design and Evaluation Models," International Journal of Computer Science and Business Informatics, vol. 17, 2017.

[36] G. C. Challco, R. Mizoguchi, I. I. Bittencourt, and S. Isotani, "Gamification of Collaborative Learning Scenarios: Structuring Persuasive Strategies Using Game Elements and Ontologies," presented at the International Workshop on Social Computing in Digital Education, 2015.

[37] J. St-Maurice, "Improving Data Quality in Primary Care: Modelling, Measurement, and the Design of Interventions," UWSpace 2017.

[38] M. M. Qasim, M. Ahmad, and M. Omar, "Conceptual Persuasive Mobile Healthcare Architecture for Monitoring Children's Obesity Status among Parents," Advanced Science Letters, vol. 22, pp. 1291-1294, 2016.

[39] M. M. Qasim, M. Ahmad, and M. Omar, "Analyzing Persuasive Mobile Healthcare Architecture Using Systematic Process Design," Journal of Telecommunication, Electronic and Computer Engineering (JTEC), vol. 9, pp. 77-84, 2017.

[40] J. O. Prochaska and C. C. DiClemente, "The transtheoretical approach," Handbook of psychotherapy integration, vol. 2, pp. 147-171, 2005.

[41] J. Brug, M. Conner, N. Harre, S. Kremers, S. McKellar, and S. Whitelaw, "The Transtheoretical Model and stages of change: a critique Observations by five Commentators on the paper by Adams, J. and White, M.(2004) Why don't stage-based activity promotion interventions work?," Health education research, vol. 20, pp. 244-258, 2005.

[42] J. H. Littell and H. Girvin, "Stages of Change A Critique," Behavior Modification, vol. 26, pp. 223-273, 2002.

[43] Fogg and J. Hreha, "Behavior wizard: a method for matching target behaviors with solutions," presented at the Persuasive technology, ed: Springer, 2010, pp. 117-131.

[44] Fogg, "Creating persuasive technologies: an eight-step design process," presented at the 4th International Conference on Persuasive Technology, California, 2009, p. 44.

[45] N. Mogles, J. Padget, E. Gabe-Thomas, I. Walker, and J. Lee, "A computational model for designing energy behaviour change interventions," User Modeling and User-Adapted Interaction, vol. 28, pp. 1-34, 2018.

[46] K. Torning, "A review of four persuasive design models," International Journal of Conceptual Structures and Smart Applications (IJCSSA), vol. 1, pp. 17-27, 2013.

[47] A. Coskun and C. Erbug, "User diversity in design for behavior change," presented at the DRS, pp. 546-559, 2014.

[48] P. Cronin, F. Ryan, and M. Coughlan, "Undertaking a literature review: a step-by-step approach," British journal of nursing, vol. 17, pp. 38-43, 2008.

[49] B. A. Cumbie, Z. Jourdan, T. Peachey, T. M. Dugo, and C. W. Craighead, "Enterprise resource planning research: where are we now and where should we go from here?," JITTA: Journal of Information Technology Theory and Application, vol. 7, pp. 21, 2005.

[50] R. C. Bogdan and S. K. Biklen, Qualitative Research in Education. an Introduction to Theory And Methods, 1998.

[51] R. Y. Cavana, B. L. Delahaye, and U. Sekaran, Applied business research: Qualitative and quantitative methods: John Wiley & Sons Australia, 2001.

[52] Y. Lin, J. Jessurun, B. De Vries, and H. Timmermans, "Motivate: Towards context-aware recommendation mobile system for healthy living," presented at 5th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2011, pp. 250-253.

[53] A. Soror and F. Davis, "Using Self-Regulation Theory to Inform Technology-Based Behavior Change Interventions," presented at the 47th Hawaii International Conference on System Sciences (HICSS), 2014.

[54] R. J. Beun, "Persuasive strategies in mobile insomnia therapy: alignment, adaptation, and motivational support," Personal and Ubiquitous Computing, vol. 17, pp. 1187-1195, 2013.

[55] T. R. Chang, E. Kaasinen, and K. Kaipainen, "Persuasive Design in Mobile Applications for Mental Well-Being: Multidisciplinary Expert Review," Wireless Mobile Communication and Healthcare, pp. 154-162, 2013.

[56] S. Consolvo, P. Klasnja, D. W. McDonald, and J. A. Landay, "Goal-setting considerations for persuasive technologies that encourage physical activity," presented at the 4th International Conference on Persuasive Technology, 2009.

[57] R. De Oliveira, M. Cherubini, and N. Oliver, "MoviPill: improving medication compliance for elders using a mobile persuasive social game," presented at the 12th ACM International Conference on Ubiquitous Computing, 2010, pp. 251-260.

[58] C. Gao, F. Kong, and J. Tan, "Healthaware: Tackling obesity with health aware smart phone systems," presented at IEEE International Conference on Robotics and Biomimetics (ROBIO), 2009, pp. 1549-1554.

[59] M. Sohn and J. Lee, "UP health: ubiquitously persuasive health promotion with an instant messaging system," presented at CHI'07 Extended Abstracts on Human Factors in Computing Systems, 2007, pp. 2663-2668.

[60] M. Kaptein, "Personalized persuasion in ambient intelligence," Journal of Ambient Intelligence and Smart Environments, vol. 4, pp. 279-280, 2012.

[61] A. Meschtscherjakov, M. Gärtner, A. Mirnig, C. Rödel, and M. Tscheligi, "The Persuasive Potential Questionnaire (PPQ): Challenges, Drawbacks, and Lessons Learned," presented at the International Conference on Persuasive Technology, Springer, 2016, pp. 162-175.

[62] C. Fernández-Llatas, J. M. Garcia-Gomez, J. Vicente, J. C. Naranjo, M. Robles, J. M. Benedi, and V. Traver, "Behaviour patterns detection for persuasive design in nursing homes to help dementia patients," presented at the Annual International Conference of the IEEE Engineering in medicine and biology society, EMBC, IEEE, 2011, pp. 6413-6417.

[63] S. Chatterjee, J. Byun, A. Pottathil, M. N. Moore, K. Dutta, and H. Q. Xie, "Persuasive sensing: a novel in-home monitoring technology to assist elderly adult diabetic patients," presented at the Persuasive Technology. Design for Health and Safety, Springer, 2012, pp. 31-42.

[64] A. Ahtinen, E. Mattila, A. Vaatanen, L. Hynninen, J. Salminen, E. Koskinen, and K. Laine, "User experiences of mobile wellness applications in health promotion: User study of Wellness Diary, Mobile Coach and SelfRelax," presented at the 3rd International Conference on Pervasive Computing Technologies for Healthcare PervasiveHealth, 2009, pp. 1-8

[65] L. K. Ping, J. P. Poh, L. K. Meng, W. Husain, and M. H. M. Adnan, "A framework of a childhood obesity intervention using persuasive web-mobile technology," presented at the International Conference on Computer & Information Science (ICCIS), 2012, pp. 50-54.

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