

Towards Developing an Interaction Design Model for Services that Utilise Mobile and Wearable Devices

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ABSTRACT

Despite how popular the wearables have become, there is still some challenges and implications for using them, which might lessen their potentials. This paper presents a preliminary empirical study to investigate how mobile and wearable devices communicate as an integrated service throughout people's daily routine. Qualitative research approach was adopted with data being gathered using diary entry study. A preliminary insight was captured based on the study, which resulted in developing an alpha version of a theoretical design model for developing the interaction for services that utilise mobile and wearable devices. The model consists of four themes, which are; notifications related, devices related, UIs design related and obstacles and challenges.

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1. Introduction

Despite the growing literature in the field of ubiquitous computing, there is still a gap in understanding how the interaction design could facilitate seamless communications between users and, mobile and wearables on one hand, and mobile and wearables on the other hand [1]. This has particularly become important with the rapid development the field of technology and specifically with the field of mobile and wearables, which has recently seen [2, 3]. The emergence of ubiquitous computing utilizing mobile and wearable devices, offers promises to free people hands as well as the restrictions of time and place as the mentioned devices could be used regardless of time and place. Such technology is unobtrusively embedded into the surrounded environment as well as our daily routines

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[1,4,5]. It would seamlessly enhance the interaction with the contexts, users and devices. Giving that, a further enhancement may perhaps be essential, which could be done by paying attention to the design of interaction.

Interaction design is specifically important in the field of ubiquitous/ pervasive computing with the adoption of services that use wearable device connected to mobile phones [6]. Although it offers flexibility by freeing users' hands, but some limitations and challenges might be introduced [7]. A few studies have featured the use of mobile and wearable devices for different purposes and contexts. Some of them introduced models and frameworks with respect to interactive services that utilise mobile and wearable devices such as for the contexts of; learning [8, 9,10], and m-health [11]. Moreover, some other models such as interaction constraint [12]; playful wearables [13]; social wearables [14]. One of them was conducted with respect to design challenges in the learning context [9], but not specifically for developing a model; the rest of the aforementioned models/ framework were not specifically introduced for developing a design model, nor they used a diary entry study for collecting data. This method is specifically effective for indirectly observing users experience when using such devices as it would support capture more details than when using the direct observation due to the idealistic of directly observing users while using their devices all day long [15]. Some others were conducted with respect to mobile and wearables but not necessarily for designing a model/ framework, but perhaps for investigating human factors that might influence the design of such services [2, 16, 17]; requirements elicitation was another aspect that some studies were conducted [18, 19, 20], however, it was not conducted for designing a model nor used a diary study. Although some of the studies adopted diary study [21, 15, 22, 23], but did not introduce a tool for interaction design.

Given the discussion so far, it is clear that there is a lack of tools for interaction design to act as a guideline for developing such services. Moreover, there is a lack of studies that identified the challenges and implication which might be raised when designing the interaction between users and devices, and the devices themselves. That would particularly be effective with the use of diary entry technique, which would provide more in-depth insight as it allows to indirectly observe users' behaviour and activity pattern throughout their daily routing. This study investigated how mobile and wearable devices could seamlessly communicate with each other's in an integrated services as well as with users. The aim of using the diary study is to capture the challenges and implications that might be arise when interacting in such context. This research was conducted based on the general aim and to answer the research questions that are outlined below:

Aim: Explore the potential of utilising mobile and wearable devices to enhance users' experience.

Research questions:

Q1) How mobile and wearable based systems could be developed to enhance the user experience.

Q2) what are the essential elements that could make the interaction between users and, mobile and wearable devices as seamless as possible.

2. Research Methodology

Qualitative research method was utilised within the user-centred design methodology with data being gathered using diary technique, which could effectively help capturing patterns of users' habits when using mobile and wearable devices [24]. Participants were asked to keep track of their use of mobile and wearable device for five days using an online Google form to record their interaction pattern. It is important to mention that in preparation for the study, an AI generated content platform was used to assist in designing the study as well as brain storm more ideas regarding the study setting. The questions were designed around the main topic of the study, which is investigating how seamless the interaction between users and the devices it is on one hand, and between the devices themselves on the other hand. The data obtained from the study was cleaned in preparation for the analysis phase. The missing data were marked as no response.

2.1. Methods

Indirect observation method was adopted in this research using diary entry technique to gather data [24, 25]. A Google form was sent to participants to record the interaction experience with the devices three times a day (mobile

and wearable). The form consists of three main sections, which are; a) notification record; b) switching devices record; summary of the day. Participants were required to fill out all sections each day, however, each section to be filled at a different and separate time throughout the day. Quantitative and qualitative data were obtained. Statistical analysis was performed for the quantitative data as well as thematic analysis for the qualitative data [26]. MS Excell was used for both analyses. Additionally, colour coding was used to highlight the emerged themes.

2.2. Participants

Four participants were invited to take part in this study, three of them completed the task of five days. However, we accepted this rate as this study was conducted to capture an initial insight regarding the implications and challenges that might arise if any, when using mobile and wearable devices either as an integrated service or a substance of each other. Participants were two males and one female; their age ranged between 20 to 65. Participants were invited personally to take part in the study using the convenient sampling method. Two of them were computer science background and the other was a medical student.

3. Results

This study was conducted with the aim of understanding users' behaviour and experience with respect to the use of mobile and wearable devices. Diary entry study was used to track users' activities to understand the behaviour and experience patterns of users. Participants were asked to log their interaction with the devices for the duration of five days. Quantitative and qualitative data obtained from the study, which helped in having an initial insight regarding the challenges and implications that might arise in terms of interaction with mobile and wearable devices as well as how the devices communicate with each other's.

The results suggest that messages such as WhatsApp and text messages are the most received notifications (66.70%); sport and health (22.20%) and 11.1% was for the reminder and calendar notifications (see Fig. 1). Moreover, the results show that the average of interruption score when receiving notification is 1.4, which indicates the interruption was at the minimum level. In the same vein, the average of ignoring notification was less than 1% which is 0.4. Moreover, 0.6% of notifications required participants to use the other device to follow-up.

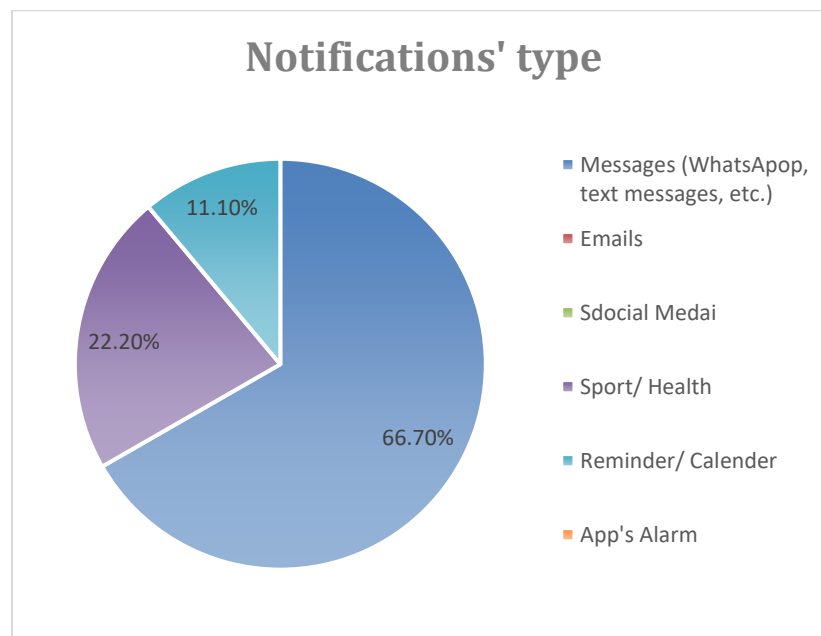


Fig.1 - Illustration of notifications' types that have been

The results indicate the smart watch is the most wearable device used by participants; moreover, the results show that the time is divided evenly between mobile phones and wearables in terms of which device participants to look at first when receiving a notification as 50% each. However, the results indicate that most of times participants

switched to mobile phone after receiving notifications (44.4%), whilst 22.2% of time the notification was opened via the wearable device (see Fig. 2). 65.6% of time, participants needed to follow up using the mobile phone after receiving notifications on the wearables. Based on the results, the main reasons for switching the device are for; (a) getting more details (27.30%); (b) hard to response (36.40%); (c) habit (18.20%) (see Fig. 3). This would suggest that the interaction with the mobile device is easier than the wearable, which could be explained due to the small screen of the wearables.

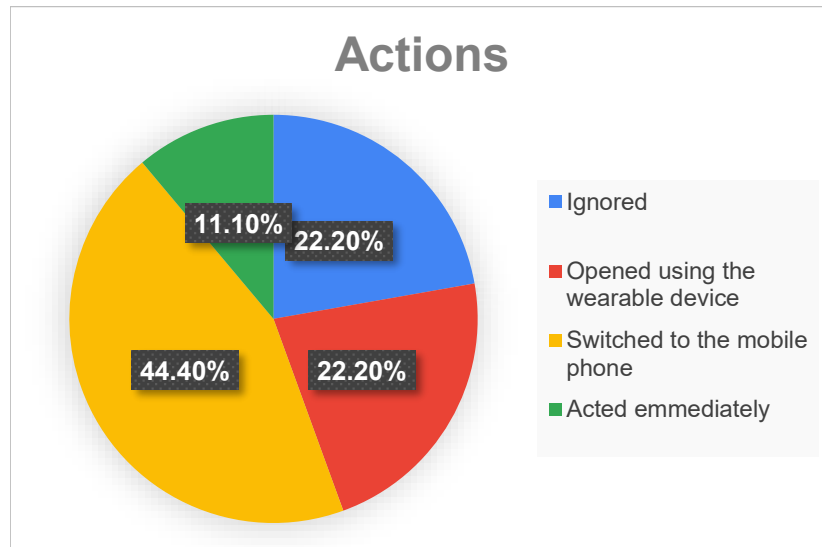


Fig.2 - Illustration of the actions performed when notifications have been

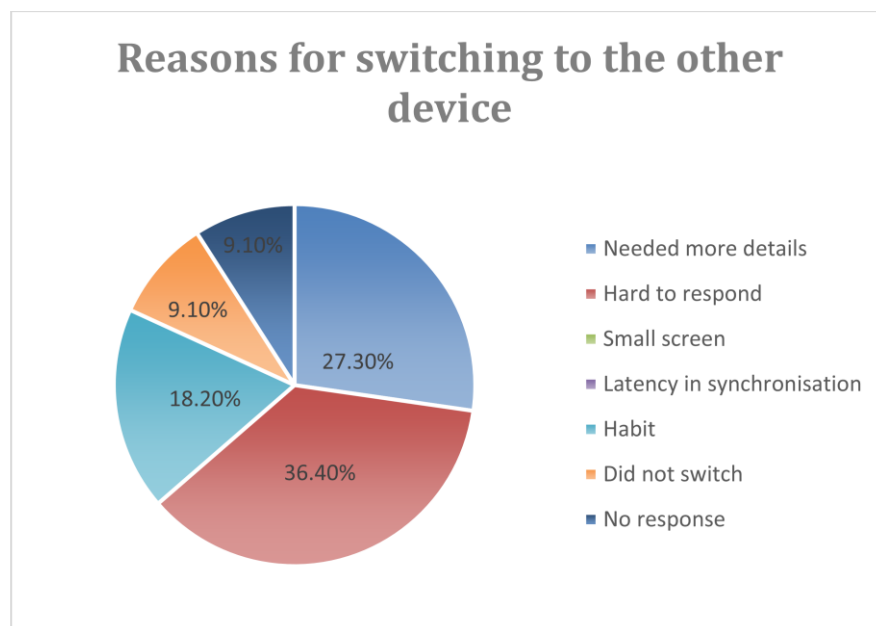


Fig. 3 - Illustration of the reasons for switching the device

The results show that the rate of interaction' difficulties was 1.25%. Interestingly, the majority of the time, participants had a neutral feeling regarding the received notification (45%). 44% of the time participants felt curious and 11% of time participant felt helpful about the received notifications. This might suggest the interaction between participants and, their wearable and mobile devices was smooth and seamless. Nonetheless, it was helpful to some extent as we mentioned earlier that notifications for messages were the most received notifications, which might indicate social communications was dominant. As indicated in the previous section, the results suggest that the mobile device is the most comfortable device to interact with in terms of getting more details and for responding to notifications. However, the results suggest the wearable device is first to interact with when receiving notifications, which would suggest that it is easier and quicker to access. Additionally, average of interruption was 1.4, which shows that the interaction through notifications was unobtrusively easy and user friendly.

The results of the current study suggest a minimal level of obstacles and challenges participants have faced when used the mobile and wearable devices. 85% of time participants' behaviour did not get affected by wearing the device, while 14% get affected in the area of exercising and sport.

4. Interaction Design Challenges Model – Discussion

The current study explored users' behaviours and experience in terms of using mobile and wearable devices with the aim of capturing interaction activities pattern. This helped to place the foundation stone in developing an interaction design model for systems/ services that utilise mobile and wearable devices. A preliminary version model was resulted from this study, which consists of four main themes; notifications related, devices related, UIs design related, challenges and obstacles related (see Fig. 4).

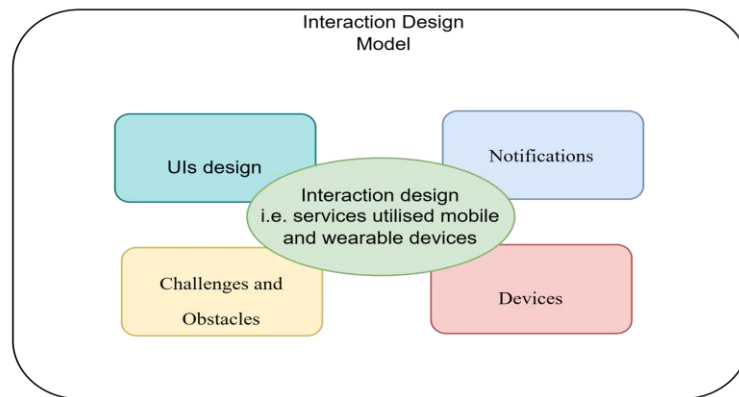


Fig.4 - The interaction design model' themes

4.1. Notifications related

Notifications are one of the most window users interact with when using mobile and wearable devices [27]. As presented in the results section, communications messages are the most received ones, which suggests designers and developer need to pay great attention to this element when designing the interaction for such services. The main benefit for this is to enhance users' satisfactions and engagements as it is the main interface for the interaction. So, it needs to be unobtrusively helpful and useful as well as brings the interaction required with the wearables to the minimum due to the small size of screen [28].

4.2. Devices related

This theme is concerned with the devices involved in the services that make use of the integration of mobile and wearable devices. This is particularly important as interaction design of such integrated services could play a vital role in the adoption's potential of the service as it would encourage or discourage the adoption [29]. Additionally, the communication and transition between the two devices is a significant element to be considered as the it needs to be as seamless and user friendly as possible.

4.3. UIs design related

The user interface (UI) design is another important element in designing such services. It is the initial site users use when interacting with such services. It plays a significant job in drawing users' attention in using the service [20]. More importantly, the interaction between the devices could play a significant part as without seamless and smooth transition, the service could consider less usable [16]. Hence, it needs to be in line with the design and usability principles to ensure seamless user interaction [30].

4.4. Obstacles and challenges related

Although, the results of the present study did not highlight significant issues in terms of using mobile and wearable devices, but it is important to take the highlighted ones into account. The integration of the wearable and mobile devices in one service has its own benefits and challenges. This theme acts as the guard that would help in troubleshooting and maintenance activities, which would significantly help reduce the time of maintenance as well as system failure. This is due to the help of the pre-preparation phase that could consider these known issues in order to embrace and address them in the early stages of the design. This would bring the waste of time, effort and money to the minimum [8, 3].

The model presented so far forms an alpha version for interaction design, which act as the bedrock for developing the full version of the model. This model is for designing the interaction between users and, mobile and wearable devices on one hand, and the two types of devices with each other's on the other hand. Table 1 illustrates how these themes could be used in designing such services alongside with the rational from the results.

Table 1- illustration of how the model could be used

Theme	Type of information could be provided	Justification based on the results
Notifications related	This theme prompt designers to take good care of designing the notification services in terms of different aspects such as actions required when receiving notifications	The results suggest that the most interaction elements were through messages' notifications
Devices related	This theme provides information of the devices involved in such system and how could be integrated and communicate seamlessly to provide a better user experience	The results suggest that participants regularly switch devices throughout the day for different purposes such as to follow-up after receiving notifications

Theme	Type of information could be provided	Justification based on the results
UIs design related	This theme provides information to act as a guideline for designing a seamless interaction experience in terms of UIs.	The results suggest that interaction design including the interfaces, could play an important part in the adoption of such services.
Obstacles and challenges	This theme provides information regarding the challenges and obstacles might raise which could hinder the adoption of such services.	Although, the results suggest very minimum challenges and problem, it is necessary to take these into consideration. More research is needed to explore other aspects related to this theme.

As Table 1 showed how the model could be used, a preliminary textual and graphical scenarios were developed for the same purpose.

Preliminary Scenario:

A possible scenario for using the model, as shown in figure 5, is to consider each theme in terms of pulling information that is related to the related design element as illustrated in table 1. Then design alternatives could be extracted based on the information provided by the model to inform the design of a mobile and wearable service.

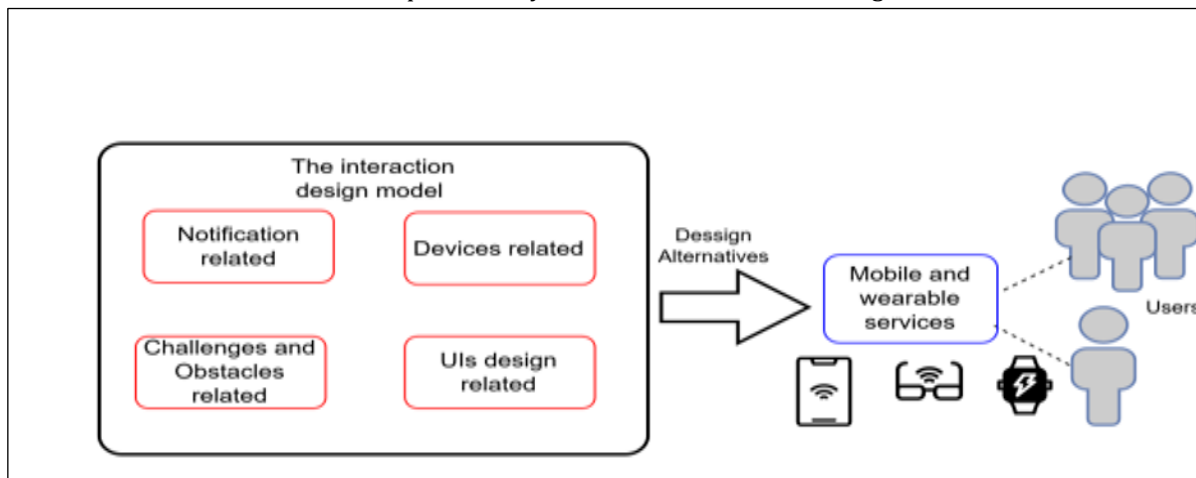


Fig. 5 - Illustration of a possible scenario of how the model could be used

5. Conclusions and further work

An empirical study utilising diary entry technique has been presented in this paper. Four participants took part in this study for the duration of five days. Participants were asked to keep record of their interaction habit when using mobile and wearable devices. The indirect observation technique, diary technique, used in this study helped obtaining an in-depth preliminary insight of how the interaction design would affect the adoption of services that incorporate the use of mobile and wearable devices. A preliminary design model, as an alpha version, was resulted from this study, which would be a great assistance for designers/ developers of such services.

However, this research encountered some limitation, such as studies related as it is limited to one single study; indirect observation, with three active participants. Having this said, further research is needed with more participants before we are able to generalise the model. Additionally, the study is limited to the use of smart watch as a wearable device, a replication of the study with the adoption of other types of wearable devices is needed.

Another aspect is related to the model itself, as it is limited to four themes which might not be a representative of all aspects related to interaction design; an extension to the model is needed. Hence, a future research direction is to use the model for designing a service that integrates both types of devices; mobile phone and wearables to collect more requirements for designing such services.

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