In the name of God, most Gracious, most Compassionate

“Mankind have not been given of knowledge except a little”

The Noble Quran (17:85)

Patient-Centred Culturally-Aware Design Approach for e-Health Acceptance

Thesis submitted in accordance with the
requirements of The University of Liverpool for the
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Dedication

To my parents and the rest of my family who accompanied me with their prayers and support throughout my PhD journey

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Abstract

The importance of information and communication technology in healthcare has recently grown to an unprecedented dimension as more people are empowered by technology to participate more actively in their healthcare processes. New online applications for accessing healthcare information and for self-diagnosis have become increasingly available to diverse patient groups of different languages, educational backgrounds, and cultural orientations. However, the design of these applications typically follows Western cultural orientations. This approach has created a gap, which makes it difficult for users, who use the systems within their own cultural contexts, to derive maximum benefits from such use. As a result, the gap impedes the uptake, market success, and effective adoption of these e-Health applications in various cultural contexts. Moreover, as healthcare organisations increasingly seek to interact with patients, often in real-time, through enhanced web-based services, patient experiences often become tied to a largely 'Western-driven' style of patient interfaces, interaction, and look and feel that negatively impact the overall acceptance of these services across different cultures. This poses a tremendous challenge to technology adoption, in particular with regard to how to design culturally-aware and patient-centred e-Health applications that reflect the cultural diversity of today's users and meaningfully empower them to better utilise such tools to enhance their day-to-day life.

This research proposes to investigate the impact of a patient-centred culturally-aware design approach on the patient acceptance of e-Health web-based services, in particular, how e-Health web-based applications can be designed in a way that maximises their usability and 'fits' them into the cultural fabrics of individuals in different cultural contexts. To address this challenge, this research work examined existing literature in the fields of culture, technology acceptance and HCI, and identified relevant constructs that were used to develop a culturally-aware technology acceptance model for electronic health. Subsequently, the model provided a means for understanding the influence of different factors affecting patient acceptance and usage which were used as a foundation to inform the design of the **Patient-Centred Culturally-aware e-Health Design Approach** (PCCeDA) framework for e-Health web-based services developments.

The novelty in PCCeDA is the notion of cultural awareness, which allows systems to personalise themselves according to a patient's cultural profile while adhering to usability principles. As a result, the interface and contents presented to a patient are both dynamically tailored to better suit that patient's cultural preferences, thereby increasing patient adoption. Based on PCCeDA, a proof of concept prototype called i-Diagnose was developed primarily to assess the validity of the framework and to answer the central questions of this research study. Evaluation results show that a patient-centred culturally-aware design approach enhances the effectiveness, usefulness and patient acceptance of e-Health web-based services in different cultural contexts.

The main contributions of this work include: (i) a culturally sensitive technology acceptance model for e-Health ('e-HTAM') where both technology acceptance model and cultural dimensions are integrated to develop the e-HTAM model. The model highlighted various issues that need to be taken into consideration when designing patient-centred culturally-aware e-Health Design Approach applications; and (ii) a patient-centred Culturally-aware e-Health Design Approach framework that allows systems to personalise both the patient interface and the contents provided to a patient to better suit that patient's cultural background. The research also includes a number of other minor contributions such as: (i) an approach for solving the static nature of Hofstede's dimensions' indexation, through the use of cultural parameters to dynamically model users' cultural states, (ii) the introduction of personalisation based on cultural factors into the e-Health web-based services domain, and (iii) shed light on the electronic health acceptance state in the UAE as compared to the UK.

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List 1: Acronyms

ACC	Accuracy
AMUCD	Activity Model for usage-centred design
API	Application Programming Interface
ASP	Active Server Pages
ASU	Actual System Use
AU	Actual usage
BMI	Body Mass Index
BMR	Basal Metabolic Rate
EHR	Electronic Health Record
GK	Gatekeeper
HCI	Human Computer Interaction
HL7	Health Level 7
I2U	Intention to use
ICT	Information and Communication Technologies
IND	Collectivism/Individualism
ND	Individualism/Collectivism
INR	International Normalized Ratio
INTR	Interactivity
IS	Information systems
IV	Independent Veritable

KB	Knowledge Base
KSA	Kingdom of Saudi Arabia
M	Mean
MAS	Masculinity
m-Health	Mobile health
NHS	National Health Service
NPCI	Non-Patient-centred Culturally-aware i-Diagnose
OWL	Ontology Web Language
PCCeDA	Patient-Centred Culturally-aware e-Health Design Approach
PCI	Patient-Centred Culturally Aware i-Diagnose
PD	Power Distance
PEOU	Perceived Ease of Use
PHR	Personal Health Record
PM	Patient Model
PMO	Patient Model Ontology
PRSN	Personalisation
pSat	Patient's Satisfaction
PU	Perceived Usefulness
RDBMS	Relational Database Management System
RDF	Resource Discovery Framework
RDF	Resource Discovery Framework
RSPN	Responsiveness
SD	Standard Deviation
SN	Subjective norm
SOC	Socio-Cultural factors
TAM	Technology Acceptance Model
Tang	Tangibility
TechDes	Technology Design factors
UA	Uncertainty Avoidance
UCD	User Centred Design
UML	Unified Modelling Language
UTAUT	Unified Theory of Acceptance and Use of Technology
W3C	World Wide Web Consortium
XHTML	Extensible Hypertext Markup Language
XML	Extensible Markup Language

List 2: Tables

List 3: Pseudo Codes

List 4: Figures

Chapter 1: Preliminaries

1.1. Introduction

With the advent of the Internet and mobile technologies, computer-based systems have actually moved away from the traditional desktop as Weiser (1991) rightly predicted more than 15 years ago to weave themselves into the fabric of everyday life and take account of people's cultural environments. In healthcare, this act of the computer reaching out to people's everyday lives (Grudin, 1990) is most profoundly noticeable in the way we use and adopt e-Health web-based applications[1].

Health informatics is an emerging field that seeks to optimise the acquisition, storage and use of healthcare information, by empowering patients to access healthcare through information and communication technology (Chismar and Wiley-Patton, 2003), and enabling access to health-related information primarily via the Internet. The future of e-Health web-based services envisions patients/users empowered by technologies to diagnose and educate themselves, and to become active participants in their own healthcare decision process (Chismar and Wiley-Patton, 2003).

However, the majority of e-Health applications systems are still being developed by a few market-dominating countries in Europe and America. The systems are typically designed following the originating country's cultural markers. Such design approach forces users worldwide to adapt to embedded cultural values in the patients' application interfaces. As a result, such systems pose usability challenges to users from different cultural or geographical zones, such as the Arab world where the culture is known to drive several aspects of community and individual lives (Wallace et al., 2013; Bandyopadhyay and Fraccastoro, 2007; Hofstede, 1984; Nisbett et al., 2001; Trompenaars and Hampden-Turner, 1997), such as web browsing and access to health services. In today's competitive market, developers of online systems, in particular e-commerce applications and websites, are increasingly realising the importance of adapting applications to a particular language, culture, and local design requirements as a way of enhancing usability and increasing market share (Reinecke, 2011).

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[1] In this work, the term health informatics application is used to refer to web-based healthcare applications and websites used by people to obtain health information, in particular, self-help medical and diagnostic services. Examples of these include WebMD and the Mayo Clinic.

Modelling patient cultural behaviour, particularly from a human-computer interaction perspective, is considered a non-trivial problem (Reinecke, 2011). Some organisations nowadays opt to address this problem by creating an 'on-demand' national patient interface for each country that uses their applications (Rogers et al., 2007). However, although this has marginally addressed the problem, today's users are very diverse; even within a single cultural context, one is bound to encounter different shades of patient groups. Research in the information systems domain indicates that such problems can be solved by employing personalisation to customise interfaces and contents according to the user's preferences (Oppermann et al., 2005).

The web has enabled health organisations in both public and private sectors to have websites for marketing their products or services; such business orientation is referred to as e-commerce in the information system development domain. The Internet is the delivery channel that makes those services globally accessible; hence, the users who will benefit from such services are spread all over the world. Modern business requirements and the diverse needs of users raise an important issue about the way those products or services are delivered through the Internet and the way they are perceived as useful by a wide range of users.

The main issue is that personalisation is based around particular patient attributes, but, as users have become somewhat 'international', possessing multiple and diverse attributes that need to be modelled, a universal web-interface style that 'fits all' becomes less valid and appropriate.

Indeed, countries have their own national cultures, which are represented by language, colours, icons, date format (Rogers et al., 2007), etc., and which convey values, such as trust and professionalism, and drive acceptable ways of social interaction or websites to visit. Moreover, the globalised labour market and migration has resulted in an interchange of people's ideas and resources, ultimately affecting those on the move as much as those who stay at home (Bruner, 2010).

Some organisations, such as Google, have sought to achieve widespread usability by adapting user interfaces to different target nations. However, such an approach has focused on a personalisation of the interface, and has given little attention to an individual's cultural norms. The personalisation has been merely based on the usability measures and design guidelines as discussed by Wroblewski (2008), Krug (2009) and Nielsen (1993, 1999); although they presented a useful and valuable foundation in usability interpretation and the design of usable objects, their guidelines were based on macro-level, 'generalised rules', and have failed to address the diverse micro levels of personal norms, which can affect a user's behavioural intention to use an application or product.

Over the years, anthropologists, such as Hofstede (1984), Hall (1990), Trompenaars (1997) and Marcus (2002), have studied culture and presented valuable results, where the cultural norms have been decoded and transformed into qualitative dimensions. However, despite their success, nowadays, those results are challenged on two fronts: firstly, those studies assessed an already designed interface that was not designed with a 'user-centeredness' consideration, which brings into question the validity of the produced results. Secondly, those studies were heavily theory based, and made few attempts to validate the results using real-world systems. Several issues based around the design of a single 'universal' interface, such as use-fit, usefulness and adoption, need to be addressed. As a result, the central concern of this research is the question of how e-Health web-based applications can be designed in a way that 'fits' the everyday fabrics of users, and enhances their usability for users with various cultural orientations.

1.2. Aim and Objectives

This research aims to investigate the influence and effectiveness of a patient-centred, culturally-aware design approach on e-Health web-based services' acceptance. The main objectives of this research are to:

1. Investigate and identify the role of the patient-centeredness and cultural factors for patient acceptance of e-Health web-based services.
2. Develop and validate an e-Health technology acceptance model that incorporates cultural factors.
3. Design, develop and evaluate a patient-centred culturally-aware e-Health information system as a proof of concept prototype for improved patient acceptance.
4. Compare the acceptance of e-Health between UK and UAE patients

1.3. Research Hypothesis

The main hypothesis of this research is that a patient-centred, culturally-aware system design approach can increase the acceptance and adoption of e-Health web-based services. As a result, the thesis aims to explore the role of a patient-centred, culturally-aware system design approach in understanding current challenges of e-Health web-based services acceptance in various cultural contexts, and how the proposed design approach could contribute to the acceptance of patient-targeted e-Health services. **This research hypothesises that a patient-centred, culturally-aware system design approach can increase the acceptance of patient-targeted e-Health web-based services**.

The above hypothesis will be tested by testing the following hypotheses:

> **H1 – Cultural factors** positively influence patients' attitude towards the acceptance of e-Health services.
>
> **H2 –** The **Perceived Ease of Use and Perceived Usefulness** of patient-centred, culturally-aware e-Health information systems influences patients' acceptance of e-Health services.
>
> **H3 – Technology design factors** (Personalisation, Responsiveness, Accuracy and Interactivity) positively influence patients' attitude towards e-Health acceptance.
>
> **H4 – Gender classification** positively impacts the adoption of e-Health web-based services.

1.4. Proposed Solution

The above-mentioned issues require the investigation of: (i) technology acceptance (Davis, 1989), (ii) culture (Hofstede, 1984; Hofstede and Hofstede, 2005; Hofstede and Minkov, 2010), (iii) patient modelling (Fischer, 2001; Addie and Taatgen, 2005), and (iv) interface and contents personalisation (Akiki et al., 2015; Brusilovsky, 2016; Oppermann et al., 2005). The researcher considers these fields as core components of modern e-Health applications design, based on existing literature. To address these issues within a healthcare domain, this research study argues for the integration of technology acceptance, cultural dimensions and human-computer interaction into a suitable framework that can be used to investigate develop and assess patient-centred, culturally-aware electronic health information systems.

Users are an integral part of such agile research or systems development as, without their satisfaction, the 'acceptance' of such systems is likely to fail. Hence, researchers and systems designers need to consider various different users' behaviours and factors that might influence their acceptance; users should be involved from the initial design stages and not after the system has been developed (Searl et al., 2010).

This research aims to investigate the influence of technology design and culture on patient acceptance behaviour, and to develop an e-Health acceptance model that incorporates technology design, cultural and social variables. The proposed model incorporates Perceived Usefulness and Perceived Ease of Use, which were based on Davis' (1989 and 1993) studies. Cultural variables of Power Distance, Individualism/Collectivism, Uncertainty Avoidance and Masculinity were drawn from Hofstede, 1984; Hofstede and Hofstede, 2005; Hofstede and Minkov, 2010. Trust was derived from Gefen (2003), Subjective Norms was adopted from Venkatesh and Davis (2000), and website design was derived from Becker (2002).

The research also seeks to allow systems to be personalised according to the patient's cultural context in order to enhance their usability. Personalising systems (Oppermann et al., 2005) ensures that neither the interface nor the contents are static, but rather, they are dynamic in nature to tailor themselves to better suit the patient, which will subsequently increase patient satisfaction and performance. Throughout the personalisation process, several factors such as country of origin, domicile, residency duration in each country, religion, age, and education level will all be taken into consideration to better customise the interface and contents.

This research is primarily 'patient centric', and the work that has been conducted to achieve the goals of the thesis includes:

- Investigation and identification of the role of patient-centeredness and cultural factors in patient acceptance of e-Health web-based services, as well as the development and validation of an e-Health technology acceptance model ('e-HTAM') that incorporates cultural and technological factors. The model highlights various issues that need to be taken into consideration when designing patient-centred culturally-aware systems.
- A patient-centred culturally-aware framework called PCCeDA, which is informed by e-HTAM findings. PCCeDA allows a system to be configured, i.e. 'personalised', according to the patient's cultural profile without violating the usability rules. This ensures that neither the interface nor the contents are static, but rather, they are dynamic in nature to be tailored to better suit the patient.
- PCCeDA was used to develop a proof of concept prototype called i-Diagnose to assess the validity of the framework and to test the research hypothesis. The results confirm that i-Diagnose is capable of customising the interface and the contents in a way that fits individual users, and that i-Diagnose can positively affect the users' behavioural attitude towards e-Health web-based services acceptance.

1.5. Research Design

This research adopts primarily a patient-centred approach. First, a critical review of the literature in relevant areas including e-Health, usability, culture, and technology acceptance was conducted. Based on the findings of the literature review, a pilot questionnaire-based study was conducted to elicit the variables that could be used to develop the proposed e-Health technology acceptance model, ‘e-HTAM’.

Next, a questionnaire-based study was carried out to assess and evaluate the reliability and consistency of the e-HTAM model, and to better understand the relationships between various variables used in the study. The e-HTAM model was subsequently used as a basis to develop a patient-centred, culturally-aware health information system framework, which was used to inform the development of the proof of concept prototype, referred to as i-Diagnose. Finally, an evaluation study was conducted using the prototype in order to validate and assess, from the perspective of potential users, the acceptability, usability and usefulness of the approach proposed in this research work. Figure 1 illustrates the overall research approach taken in this thesis, as discussed above.

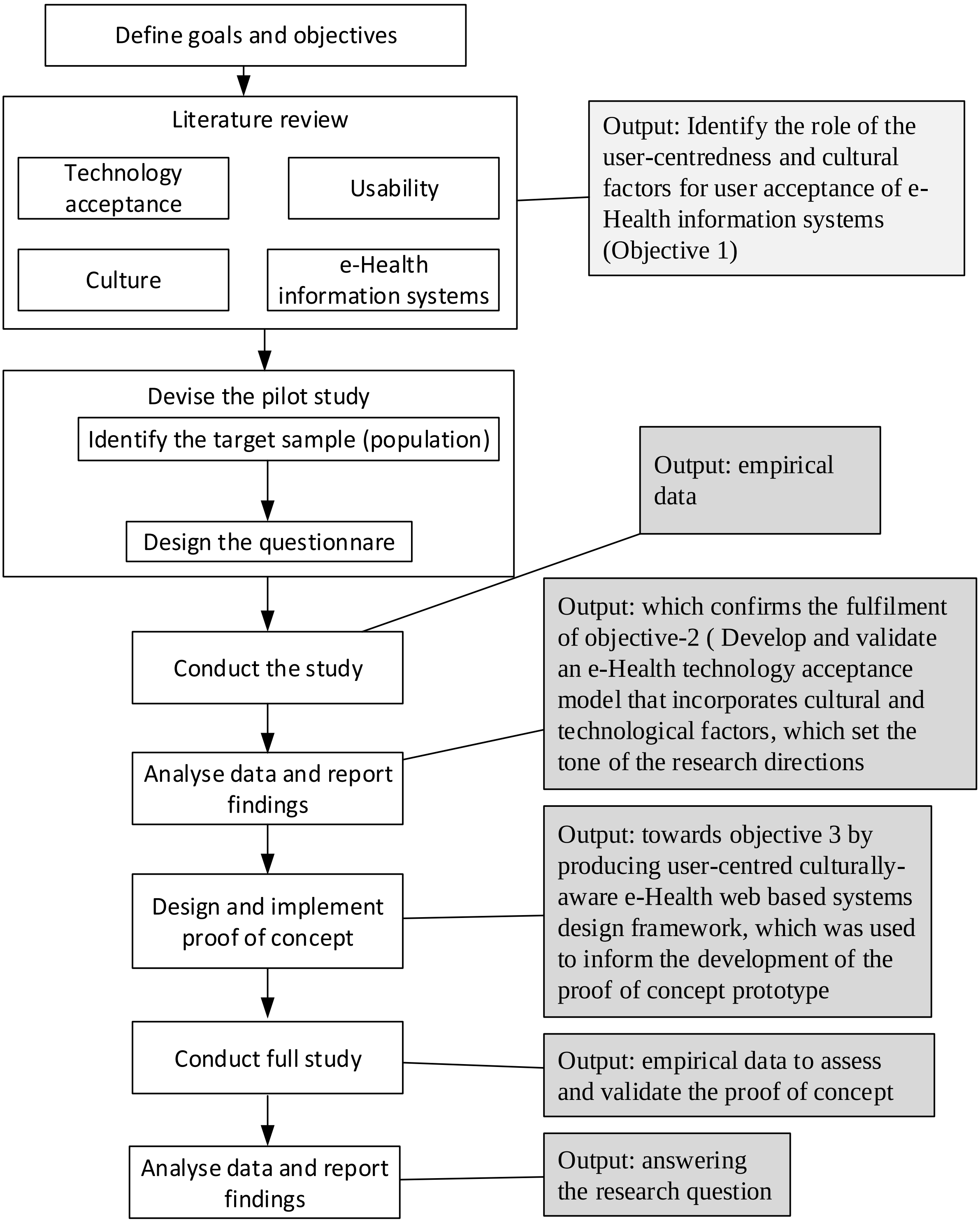

Figure 1: The research design roadmap

1.6. Contributions

A central focus of this research is to investigate the impact of a patient-centred, culturally-aware design approach on patient acceptance of e-Health web-based services, and to develop an e-Health acceptance model that incorporates technological, cultural and social variables. By developing a culturally sensitive technology acceptance model for e-Health (e-HTAM) where both technology acceptance model and cultural dimensions are integrated, this work contributes to the research areas of patient-centred design, culturally-aware e-Health, and technology acceptance. In particular, the proposed model highlights various issues that need to be taken into consideration when designing patient-centred culturally-aware e-Health Design Approach applications. We outline the main contributions of the study as follows:

- A culturally sensitive technology acceptance model for e-Health (e-HTAM) that incorporates known cultural dimensions as a way of enhancing the acceptance of e-Health web-based technologies. The model highlighted various issues that need to be taken into consideration when designing e-Health applications for different cultural context.
- A framework that allows the personalisation of both the patient interface and application contents provided to a patient to better suit that patient's cultural background.

The research work also includes a number of other contributions such as:

- An approach for solving Hofstede dimensions' indexation (Hofstede, 1984; Hofstede and Hofstede, 2005; Hofstede and Minkov, 2010), through the use of culturally-aware personalisation for modelling users' cultural contexts.
- The introduction of culturally personalised patient interfaces based on the patient's cultural variables for the design of more usable e-Health web-based applications.
- Enhancing an understanding of the effect of cultural variables on the users' perceived acceptance of e-Health information systems through a study of two culturally diverse regions, the UAE and the UK.

1.7. Thesis Structure

This thesis is structured into six chapters. Chapter one presents an overview of the research. Chapter two discusses a review of the state of the art in e-Health information systems, and patient-centred design, with the goal of identifying relevant design elements that need to be taken into consideration for the latter part of this research. The chapter also reviews the literature in technology acceptance in order to identify the factors that are very likely to impact the users' behavioural intentions to accept or reject health informatics.

In Chapter three, an e-Health Technology Acceptance Model (e-HTAM) that incorporates cultural and technological factors is presented. The chapter also reviews the literature in cultural theories, and also includes recommendations to inform the direction of the search, and the design of a technical framework that will be used to develop the proof of concept prototype in chapter four.

Chapter four presents a novel approach to integrate cultural and technological factors to design a patient-centred Culturally-aware e-Health design approach (PCCeDA) framework. PCCeDA was employed to develop a bespoke prototype 'i-Diagnose' as a proof of concept.

Chapter five discusses the evaluation of the prototype based on the data collected form the participants. Chapter six concludes the thesis, highlights the limitations of the research, and presents recommendations for future direction.

Chapter 2: Electronic Health Systems

2.1. Introduction

e-Health information systems are a means by which to deliver health services through electronic means; this is generally seen as a strategic tool for overcoming the challenges faced by healthcare sectors worldwide (Chismar and Wiley-Patton, 2003). The huge potential that is attributed to e-Health to help balance an enormous and consistently growing healthcare demand with limited resources has already led to an increased use of the Internet as a source for health information and service delivery. Additionally, the market for information technology in healthcare is expected to grow even further (Ganesh, 2004).

The use of computers to support medical decision-making was very noticeable during the 1980s, as technologies became ubiquitous in their availability, with increasingly powerful tools enabling healthcare organisations to design and develop systems that suited their needs. The linkage of systems emerged in 1989 when multiple disciplines began to work together to develop integrated systems utilising new database technology and the power of networks (Eysenbach, 2001).

With its reach, the Internet offers the possibility to deliver healthcare on a global as well as a local level. The Internet can serve as a tool to improve access to many services to geographically dispersed populations, support information exchange, increase revenue, reduce costs and improve the quality of care provided to patients (Ganesh, 2004). The opportunity to link patients to healthcare professionals via ICT and healthcare professionals on different levels to one another is attractive and appealing to both practitioners and patients around the world (Forkner-Dunn, 2003).

For many people, the term e-Health information systems might seem rather a complex and unfamiliar one, but in reality e-Health information systems is a healthcare branch that is primarily focused on providing the healthcare professionals with sufficient knowledge about a patient’s medical status, in order to take the proper course of action ‘decisions’ to treat the patient (Mukherjee and Nath, 2007). Information technology is a core element in e-Health information systems, but their scope is broader than just information technology. They also aim to improve access to and quality of healthcare services for patients; Mukherjee and Nath (2007) argued that the future of these systems envisions patients who are empowered by current health information relative to diagnosis and treatment to take part in their health decision-making without having to leave the house.

e-Health information systems emerged as a discipline during the transition from the industrial age of medicine to the information age of healthcare; they began as medical and nursing Informatics during the 1970s, where the exponential development and growing availability of steadily less expensive hardware, more powerful software and the advent of microcomputers further empowered the field (Cesnik and Kidd, 2010). They have evolved to address the desire to benefit from the advancements in technology for the better provision of healthcare. The transition was gradual, from paper-based to electronic data processing in health through the use of health information technology in healthcare.

The UK National Health Service (NHS) defines e-Health information systems as the knowledge, skills and tools which enable information to be collected, managed, used and shared to support the delivery of healthcare and promote health (cln.NHS.UK, 2013). Pagliari et al. (2005) suggested a common definition of e-Health information systems based on the work of Eng (2002), which, according to Pagliari et al. (2005), aptly represents the phenomenon. This definition is regarded as the most suitable as it highlights the particular role played by the Internet in the health domain. Accordingly, e-Health information systems can be defined as the use of emerging information and communication technology, especially the Internet, to improve or enable health and healthcare (Pagliari et al, 2005).

The term medical informatics encompasses fields that do not consider information technology policies, organisational and social aspects; it is rather rooted in medicine and computer science, providing the tools necessary to apply the knowledge in the medical decision-making process. The structure and manipulation of the information in the medical domain through the employment of different algorithms is known as biomedical informatics (Hovenga and Kidd, 2010). According to Hovenga and Kidd (2010), the term information management and technology refers to the description, collection and management of information from various sources, and its processing and delivery. Information management and technology support the delivery of care, enhanced organisational performance, business problem solving, and business strategies development and service.

As can be seen in Figure 2, the e-Health information system is a composition of knowledge and information that is supported by technology, people and processes. The level of success in combining those composites dictates the level of quality of the delivered services.

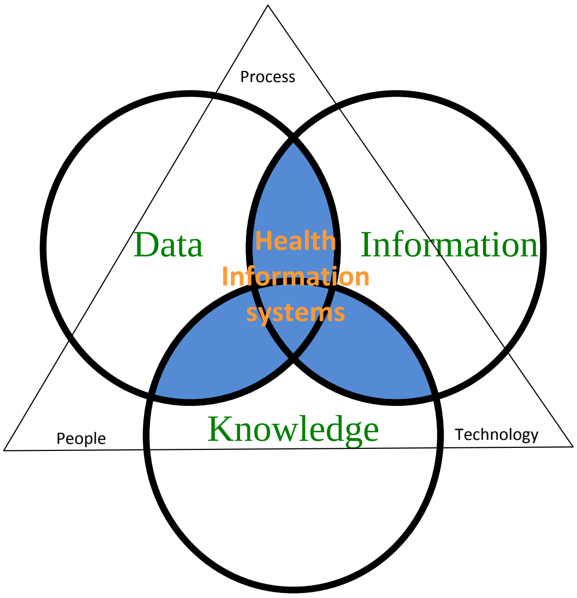

Figure 2: Health Information system composites (re production from oit.edu)

General Practice forms the core of patient information management in primary care and covers a broad range of issues. The doctor, ‘general practitioner’, or physician, cares for all patients irrespective of their age or class, etc., and the physician usually needs to maintain a longitudinal record of the patient’s history with the ability to summarise the records if the patient moves to another area. Nevertheless, diagnostic tools, appointment management, practice administration and patient billing are also core to general practice nowadays (Rector, 2011).

Standards are the key towards sharing and exchanging information; they are crucial to facilitate the linkage between systems “interoperability” through an apparently seamless integration of highly distributed systems (Lopez and Blobel, 2009). The Electronic Health Record (EHR) for example, requires some standards to index, integrate, migrate or catalogue health-related information to retrieve and to obtain uniform clinical data for research purposes. Systems such as FreeMed, openEHR, GNU Health and Clear-Health that are designed for different policies and frameworks; would benefit from interoperability framework; such as Health Level 7 (HL7) (Benson, 2012; Lopez and Blobel, 2009).

This research focuses on the patient side of this diverse domain. The following section defines the term e-Health, and then highlights the key area where e-Health is employed to serve the patients.

2.1.1. e-Health

The term e-Health refers to healthcare practice supported by electronic processes and communication, and was barely in use before 1999 (Della Mea, 2001). The usage of the term varies; it could be argued that it is interchangeable with e-Health information systems, with a broad definition covering electronic and digital processes in healthcare, while others use it in the narrower sense of healthcare practice using the Internet (Ball and Lillis, 2001; Eysenbach and Diepgen, 2001). Other definitions are very specific and focus on a particular aspect of healthcare, while others comprise virtually everything related to computers, medicine and health.

The Internet nowadays provides people with a vast amount of medical and health information about diseases and their associated symptoms. It is entirely up to the individual how to use this information. Internet surfers uses the Internet to gather information about their health conditions to educate themselves. Some also use the Internet to communicate with health professionals and the larger community, to share and learn from their experiences of similar health issues.

e-Health can encompass a range of services or systems such as electronic health records, telemedicine, consumer e-Health information systems, health knowledge management, virtual healthcare teams, mobile health (m-Health), medical research using grids, e-Health information systems and cyber medicine. The following paragraphs will briefly highlight various forms of EHR, which is a personal health record where health data and information related to the care of a patient are maintained electronically in a centralised location, where it can be accessed through different protocols (Wright et al., 2013, Ashraf et al., 2015). The data is normally entered by physicians, nurses or medical experts. The records provide a complete and accurate summary of an individual's health history. At the moment, medical records are available in two forms: paper-based and electronic.

Information retrieval is one of the key objectives behind computerisation of health records as it provides a rapid real-time access to clinical data (Courtney et al., 2013). Treating patients is a complex task, as it requires the knowledge of current symptoms, previous illnesses, family medical history, etc. The EHR has proved to be crucial in such a consultation process, as it provides history of previous consultation(s), results of current medical tests and a list of possible drugs and their various side effects.

However, privacy is a controversial issue in the EHR domain (Baskaran et al., 2013), as network hacking is becoming very common; thus, storing health data that is accessible through the Internet can cause fear of exposure by unauthorised people. Other threats also exist to EHR confidentiality, such as accidental disclosure, insider subordination and insider curiosity (Courtney et al., 2013).

Personal health is one of e-Health emerging fields, as services personalisation is currently at the helm of the patient-centred information technology domain, which has triggered the need for electronic tools that allow individuals to personalise their health needs. Personal health is the means that allows individuals to be able to manage share and store their symptoms and health experiences in a secure and conducive environment (Frost and Massagli, 2008, Röcker et al. 2014). It is a relatively new paradigm, as currently medical data is controlled by health organisations and the patients have little if any control over it. Personal Health allows the users to create their own personal health information space; it is expected to be the next generation of patient-centred e-Health information systems, and it is currently considered as a part of the medicine 2.0 domain. Frost and Massagli (2008) argued that empowering users to contribute positively and act responsibly in terms of their overall health status is one of the main objectives of personal health.

One of the major anticipated benefits of personal health is the mobility of users' health data. This is crucial, as in case of emergencies their medical records' accessibility might prove to be vital for their treatment (Frost and Massagli, 2008). The personal health record should ideally contain allergies, medications, surgeries and other health or medical data that physicians may need to make an informed treatment (Agarwal et al., 2013).

One of the e-Health branches is e-Patient, which is about empowering and engaging patients to access and contribute to their health management decision-making process (deBronkart, 2010). There are some success stories for the e-Patient paradigm: as Jacobson (2007) reported, the Internet has played an important role in helping people cope with their diseases. Feder and

Sands (2008) argued that online health-related forums have become an important healthcare resource, while Ferguson and Frydman (2004) stated that e-Patient is one of the most ‘recent’ important medical revolutions.

There is a need to further evaluate and explore the effects of e-Patient systems, and how they can improve health outcomes and generate cost-saving services are ongoing.

2.1.2. Brief History of Healthcare Information Systems Development

The history of healthcare information systems development reaches back about 50 years. Experiments with computerised medical record-keeping began in the 1960s (Goldschmidt, 2005). At the same time, the concept of e-Health applications seemed to find a permanent position amongst academic interest groups (Wilson et al., 2004). By the mid-70s, computers were widely used in hospitals (Goldschmidt, 2005), as the benefits of using information technology to manage their complex and diverse work environment became evident. In the early 80s, the framework of medical information science was vacillating (Blum, 1984), although it was clear that the use of computers would continue to have a major impact on medicine and healthcare delivery.

In the past decades, we have seen major changes in e-Health applications. Some reasons for this are that nobody was able to predict the advent of the personal computer in the 1970s, the worldwide web in 1991, the rapid rise of the Internet, or the spread of social media in this century. Foremost, however, nobody expected that it would not be primarily the hardware or the software but the human factors that would become crucial for the successful applications of computers in healthcare.

In the past, sometimes unrealistic expectations were held, e.g., regarding medical decision support systems, or the use of electronic patient records. Although the technology was widely available, some applications in healthcare appeared to be far more complex than expected. Healthcare processes can seldom be fully standardised. This holds even more for individual patients and their diseases. Humans are involved in at least two very different roles in the loop of information processing: as subjects delivering patient care, and as subjects who are the objects of care, ‘the patients’. Furthermore, medical informatics lacks a specific methodology; all its methods have been borrowed from neighbouring disciplines such as physics, mathematics and, of course, computer science. In addition, human factors play a major role in applying computers in healthcare. Everyone pursuing a career in biomedical informatics needs to be very aware of this.

It is to be expected that patients and their relatives will request an increasing role in using computers for health. There is also a strong demand to use the computer for the assessment of the quality of healthcare. All this implies that research in medical informatics is much more challenging than was thought in the past.

2.1.3. Benefits of e-Health Information Systems

The Internet gives more power to patients, as it enables them to collect health information, supporting self-help and widening patient choice, activating and allowing them to assume responsibility for their own health. e-Health information systems services are easily reachable, they are available 24/7 and they facilitate self-directed learning, thus making it more convenient for the users (deBronkart, 2010). Additionally, users may value the anonymity of the service, as there are certain health-related issues one might be interested in learning about but may not feel comfortable talking about with someone face to face (Powell and Clarke, 2006).

The application of the Internet in healthcare has a strong influence on the relationship between the patient and the healthcare provider. The shift of power to the patient can help create stronger partnerships between patients and doctors since the Internet not only offers patients the ability to search for and collect health information, but it can also enable them to communicate directly with healthcare professionals (Khoumbati et al., 2010). Another area that is becoming more tangible due to the Internet is the area of P2P (patient-to-patient) through the use of social media and forums, yet another important issue in healthcare. These forms of communication have changed the traditional ways of preventative healthcare and health promotion by offering both interpersonal interaction and social support (Stojmenova et al., 2011; Eysenbach and Diepgen, 2001), which has contributed positively to the service quality for patients, as it has further improved. This is because the flow and exchange of information between doctor and patient, and especially between doctors and other health professionals, is both facilitated and supported. Professionals increasingly recognise the potential of using the Internet to improve the quality of their services while simultaneously reducing costs (Mullner and Chung, 2002).

The above-mentioned suggest that the Internet enables healthcare providers to increase the quality of healthcare by being able to provide more patient-focused and tailored healthcare to their patients.

2.1.4. Interface Design Challenges in the E-Health Information Systems Domain

Nowadays, and due to various technical and sociocultural developments, e-Health information systems are considered as complex sociotechnical systems (Berg et al., 1999). Therefore, e-Health information systems should be based on understanding a variety of end-user groups and their norms and needs, and, most importantly, their dynamic environmental context, as increasing usability of interfaces will positively influence users' satisfaction (Hayrinen et al., 2008).

System design should respect and cater for users' techno-cultural preferences, as most of the e-Health information systems have originated from the West, without due consideration of foreign user behaviour, cultures, environments and motivations. As a result, it can be difficult for users who are from different cultural or geographical zones to adopt such applications. Mohamed et al. confirmed through empirical validation that users' cultural attributes do affect their acceptance behaviours. They further stated that the intention to use mobile-based e-Health information systems is formed by the perceptions of the user of m-Health technology design approach, especially the navigation and the data presentation on the mobile device (Mohamed et al., 2011)

Although many studies have shown positive outcomes regarding e-Health information systems, a number of serious challenges have also been identified which are, to a great extent, affecting the adoption of the technology. Due to contradictory results, several researchers (Chaudhry et al., 2003; Goldschmidt, 2005) have emphasised the need for further research in order to realise the practical benefits of, and challenges for, the technology adaptation. The lack of a patient-centred, culturally-aware design approach seems to be the issue that is affecting user-targeted e-Health information systems acceptance. Berg (2001, p.92) argued that successful healthcare information application/tools "require proper support by both central management and future users". This argument has been supported by many researchers, where the users' involvement should be from the initial design process, rather than involving them in the evaluation of the product after it has been developed (Digión and Mabel, 2012; Esteves and Andrade, 2011;

Sharp et al., 2011). Zhang (2005) further argued that e-Health information systems are a human project rather than an IT project. He further called for a wider consideration of human factors during their design and development . Tang et al. (2006) emphasised that all stakeholders (practitioners, clinicians, social workers, users/patients, IT providers, researcher and health providers) should play key roles in developing patient-centred e-Health information systems, as this will have a positive impact on widespread adoption of the technology and address the culture-ability and user-centeredness of the design.

Involving users can be achieved by conducting empirical studies that focus on studying the influence of patient-centred, culturally-aware e-Health information system design on technology acceptance/adoption. Insufficient user involvement in the design and product architecture of e-Health information systems and the lack of such systems impact negatively on the adoption and the acceptance of such systems

One of the biggest risks faced in healthcare information technology development seems to be the insufficient understanding of complex healthcare environments and processes. In the early 90s, Rector et al. (1992) wondered about the possible explanations for the undeniable fact that the healthcare information community has not been notably successful in producing systems that are widely used in routine medical practices. The authors concluded that: it is all too easy to blame the doctors for resisting the acceptance of new technologies that change the norms of their practices. The alternative explanation for this lack of success is that our systems have rarely actually met medical requirements or been usable in clinical conditions. Many researchers have strongly emphasised that e-Health information systems should be understood as complex sociotechnical systems (Berg et al., 1998; Effken 2002; Kuhn and Giuse, 2001; Giuse and Kuhn, 2003).

Therefore, the software development and integration in healthcare has to be based on an understanding of a variety of user groups and their needs, and the dynamic context of healthcare work, which is characterised by a diversity of processes (Häyrinen et al., 2008; Tang et al., 2006). According to this view, new analytical approaches are needed to encompass the complexity of changing systems and multiple interacting users (Effken, 2002). For the reason that much healthcare work is collaborative, the information system should support communication among healthcare professionals as its core mission (Walldén et al., 2007a; Weng et al., 2007; Giuse and Kuhn, 2003). Tang et al. (2006) have argued that multiple stakeholders such as patients, providers, employers, tax-payers, governments, and research institutions must play key roles in developing healthcare information technology more fully and in overcoming the barriers to widespread adoption. The argument has been supported by other researchers (Kuhn and Giuse, 2001; Giuse and Kuhn, 2003), who also have suggested several concrete actions: the adoption of highly participatory and evolutionary software engineering processes, cooperative work practices, and methods combining user participation with recognition of the specific healthcare context.

From the above, it can be concluded that summarised that e-Healthcare systems design would benefit from the appropriate inclusion of cultural awareness, user-centeredness, service tangibility, service quality privacy and security.

2.2. e-Health Technology Design

Human Computer Interaction (HCI) goes back to the early 1980s (Kotze, 2000). Since then, various definitions for the term have been introduced. Leventhal and Barnes (2007, p. 15) defined it as "*the discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them*". Johnson (2004) defined HCI as "*improving the many factors that influence the effectiveness and efficiency of computer use*". From the above definitions HCI can be viewed as an interdisciplinary field of research that focuses on increasing user satisfaction and performance through provisions that deliver a more patient-centred 'usable' interface (Bandyopadhyay and Fraccastoro, 2007).

According to Diaper and Stanton (2004, p. 20), HCI is a specialised sub-discipline of ergonomics for two reasons:

1. It restricts itself to the study of systems that have a computer component
2. It emphasises human psychology more than traditional ergonomics

The above-mentioned reasons are based on the emphasis on matching human needs to the device's physical capabilities; this could be due to the fact that computers are tools that enhance human mental abilities (Diaper and Stanton, 2004). Indeed, HCI is all about the design of computer systems with the aim being to support people so that users can carry out their activities as productively as possible and in a safe way. Diaper at al. (2004) emphasise that HCI has both a broad and a narrow definition: the broad view being that HCI is concerned with everything to do with people and computers, whereas the narrow view is concerned with usability, learnability, and intuitiveness, with a focus on the patient-centred Interface. Designing a patient-centred Interface implies the study, planning and design of interaction between the users and the computers (Rogers et al., 2007). Users in this context are those who directly interact with the computer.

In the context of this research, HCI theories and methods were used to design, implement and evaluate a patient-centred culturally-aware e-Health information system's systesm to study the impact of user-centeredness on the acceptance of a cross-cultural e-Health information system.

The next section and later text will discuss the concept of technology acceptance, and assess its relation to users' behavioural intention to use technologies. These sections will also discuss the role that technology acceptance plays in the causal relationships between system design features, perceived usefulness, perceived ease of use, attitude towards using, and actual usage behaviours. They will also discuss the relation between technology acceptance, usability and e-Health information systems, in an attempt to better understand the issues surrounding e-Health information system acceptance in cross-cultural settings.

2.2.1. Technology Acceptance

As new Information Systems (IS) infiltrate hospitals, workplaces, homes, and classrooms, research on user acceptance of new technologies has started to receive more attention from professionals as well as from academic researchers. Developers and software industries are beginning to realise that lack of user acceptance of technology can lead to loss of money and resources (Hossain et al., 2009).

Studies on information technology continuously report that user attitudes are important factors affecting the success of the produced system. Davis and Venkatesh (2004) suggested that users formulate a positive attitude towards technology when they perceive that technology to be useful and easy to use.

In studying user acceptance and use of technology, the Technology Acceptance Model (TAM) is one of the most cited models (Khushman et al., 2009). TAM (Figure 3) was developed by Davis (1989) and jointly extended by Venkatesh (2000) to explain computer-usage behaviour.

This section aims to position the study in relation to the technology acceptance of existing literature, and to provide the base for a patient-centred, culturally-aware e-Health information systems technology acceptance model that will be developed through empirical validation to further support the work presented in the later chapters of this thesis.

2.2.2. Technology Acceptance Model

TAM (Davis et al., 1989, 1993, 2004) is an Information System theory that models how users come to accept and use a technology; the model suggests that, when users are presented with a new software package, a number of factors influence their decision about how and when they will use it, notably Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Technology with a high level of PU and PEOU is more likely to induce positive perceptions. The relation between PU and PEOU is that PU mediates (by mediate we mean reduce or eliminate) the negative effect of PEOU on attitude and intended use.

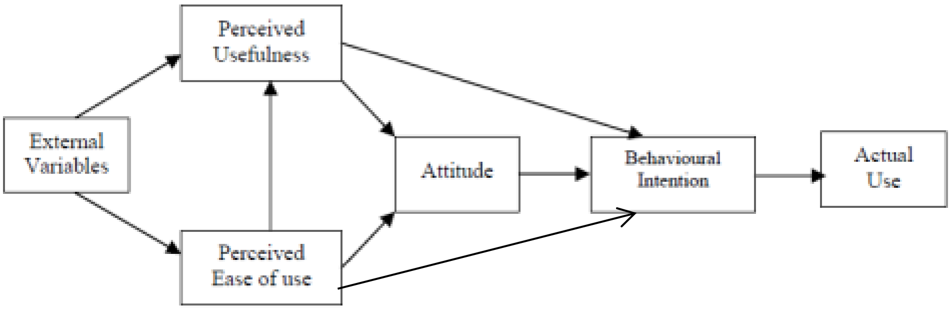

Figure 3: Technology Acceptance Model (TAM)

(Davis, 1989)

The components of TAM (Figure 3) are defined as follows (Davis, 1989):

- **Perceived ease of use** was defined as the degree to which a person believes that using a particular system will be free from effort. Ease of use was seen to include physical effort, mental effort, and ease of learning.
- **Perceived usefulness** was defined as the degree to which a person believes that using a particular system will enhance his or her job performance. Usefulness was found to incorporate the categories of job effectiveness, productivity, time saving and importance of the system to the user's job.

- **Behavioural intention** was the measure of the strength of one's intention to perform a specified behaviour.
- **Attitude** was defined as the individual user's positive or negative feelings about performing the target behaviour.
- **Actual use** was measured in terms of the user's frequency of system use (how often) and the volume of system use (how much).

TAM has generally been seen as a prudent and well-tolerated model that predicts acceptance of an information technology. TAM has mainly been tested (as well as developed) within the US, which is by far the earliest and most extensive user of what we still think of as ‘new technology’ (Davis et al., 1989, 1993, 2004).

TAM specifies the causal relationships between system design features, perceived usefulness, perceived ease of use, attitude towards using, and actual usage behaviour (Davis et al., 1993, 2004). Overall, TAM provides an informative representation of the mechanisms by which design choices influence user acceptance, and should therefore be helpful in applied contexts for forecasting and evaluating user acceptance of information technology (Khushman et al., 2009; Venkatesh and Davis, 2000, 2008; Gefen et al., 2003).

TAM supposes that the influences of external variables on intention to use can be fully mediated by perceived usefulness and perceived ease of use (Davis, 1989). Internet-based consumer services acceptance is viewed as an individual’s psychological state with regard to user’s intended use of a particular technology.

Despite it is publicity TAM has gained, it was criticised by Gefen and Straub (1997), who argued that it predicted behavioural intention to use but failed to predict actual usage behaviour. Furthermore, the fact that TAM does not consider any social factors that might affect technology acceptance and usage has been stated to further affect its overall prediction power (Khushman et al., 2009).

To counter the influence of the social and cultural factors, another model (TAM2) was later introduced by Venkatesh and Davis (2000) and further studied by Bandyopadhyay et al. (2007), where the role of social influence in the process of user technology acceptance was included.

Extended Technology Acceptance Model

TAM2, which is an extension of Davis' (1989) TAM, shows the influence of three interrelated social forces that influence users to accept or reject technology, namely: subjective norms, voluntariness, and image (Figure 4), while in TAM3 anchor and adjustment variables were incorporated into the model (Figure 5).

The Subjective Norm (SN) in Figures 4 and 5 was defined as a person's perception that most people who are important to them think they should or should not perform the behaviour 'imitation' in question (Fishbein and Ajzen, 1975). The SN is included as a direct determinant of behavioural intention in the theory of reasoned action (Fishbein and Ajzen, 1975) and the subsequent theory of planned behaviour (Ajzen 1991).

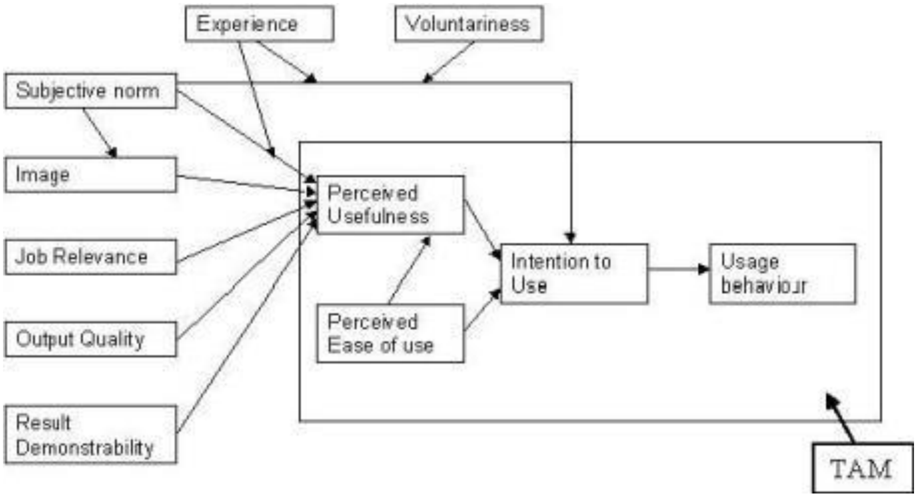

Figure 4: Extended TAM Model (Venkatesh and Davis, 2000)

According to Venkatesh and Davis (2000), voluntariness and compliance with the social norms is important, and this refers to the extent to which potential adopters perceive the adoption decision to be non-mandatory. The authors found that subjective norms have a significant effect on perceived usefulness and intention to use. They claimed that this is derived from two processes, internalisation and identification. The rationale of the internalisation effect is that: if a superior or co-worker suggests that a particular system might be useful; a person may come to believe that it is actually is useful, and in turn form an intention to use it (Venkatesh and Davis, 2000).

Image or (Identification) refers to the extent to which using the new technology will enhance and improve a person’s status. Thus, if an individual believes that using new technology will raise her or his status within the work group or family settings, s/he is more likely to use that technology (Moore 2000).

In 2008, Venkatesh and Bala (2008) produced TAM3, which included three variables of TAM2 that had not previously been empirically assessed by Venkatesh and Davis (2000) PEOU to PU, moderated by experience; computer anxiety to PEOU, moderated by experience; and PEOU to behavioural intention, moderated by experience. The results obtained by the TAM3 experiment were, in broad terms, in-line with Venkatesh and Davis (2000) results, as PEOU, result, image, demonstrability and subjective norms were all significant predictors of PU, while output quality and job relevance reported a moderate effect on PU. The results also confirmed that the effect of the subjective norm on PU was moderated by the experience. In terms of PEOU, computer playfulness, perceptions of external control, computer self-efficacy and computer anxiety were significant predictors of it.

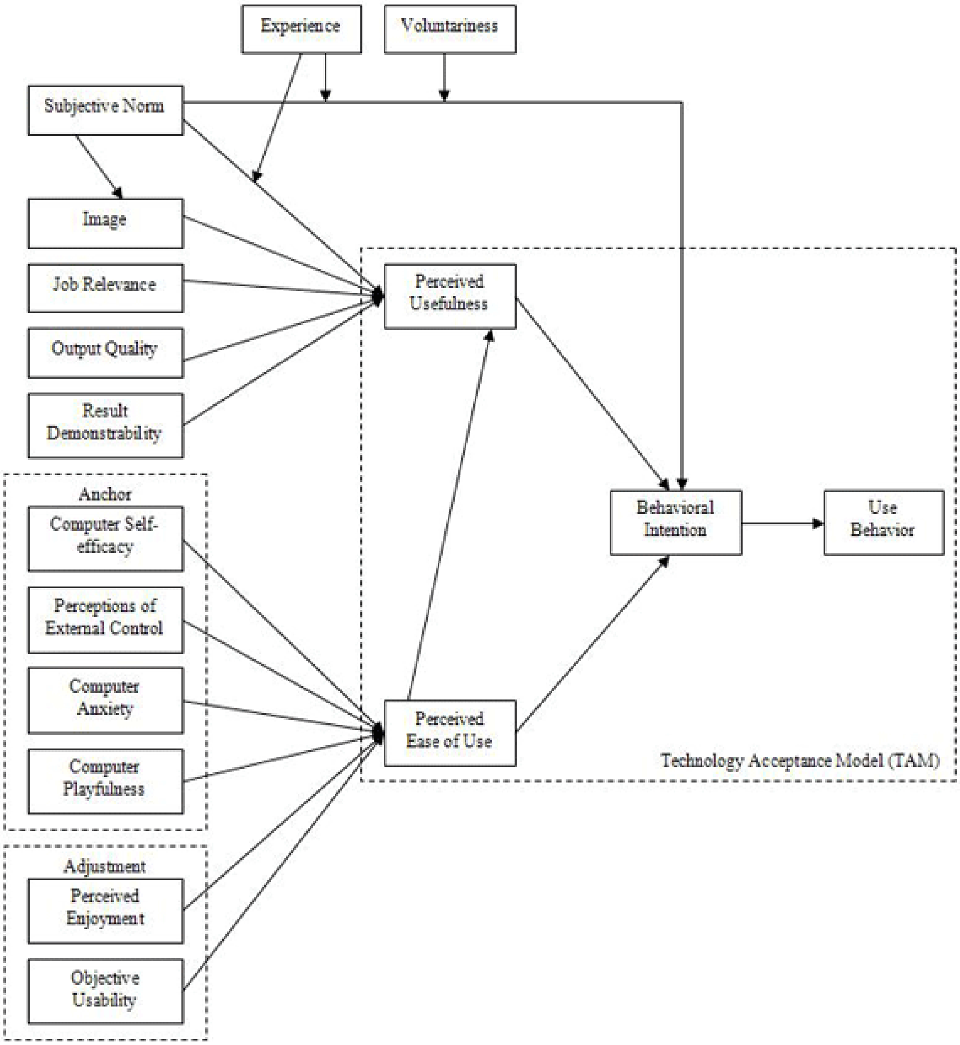

Figure 5: TAM3 (Venkatesh and Bala, 2008)

The above discussion suggest that social factors such as word of mouth and other people's opinion can affect attitudes towards using technology. This is very visible in Arab culture, which has been described as an oral-dominant society, i.e. where people prefer speech to other communication methods (Akour, et al., 2006). Word of mouth is considered one of the most effective marketing tools within Arab culture. It is therefore proposed that the subjective norm will be one of the important factors affecting a user's intentions in Arab culture.

2.3. User Centred Design

The ISO 13407 standard (1999) describes user-centred design (UCD) as an approach to interactive system development that focuses specifically on making systems usable. The objective of designing systems for usability is to enable the users to achieve their goals and meet their needs in a particular context of use (ISO 9241-11, 1996). The standards define usability as the extent to which a system can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

Nielsen (1993) stated that the two most important issues for usability are the users' tasks and their individual characteristics and differences. Nielsen further elaborated that usability has multiple components and is traditionally associated with the five usability characteristics (learnability, efficiency, memorability, errors, and satisfaction).

The framework presented in Figure 6 describes the components of usability and the relationship between them as presented by ISO 9241-11 and Nielsen.

Although both the above definitions provide some design guidelines, it is the ISO 13407 standard (1999) human-centred design process for interactive systems which incorporates the ISO 9241-11 definitions for usability and context of use, and provides guidance in designing systems with high usability. As indicated in the ISO 13407 standard, the rationale for adopting the UCD process is to:

- Make systems easier to understand and use.
- Improve user satisfaction and reduce discomfort and stress.
- Improve the productivity of users and the operational efficiency of organisations.
- Improve product quality and appeal to the users to increase competitive advantage.

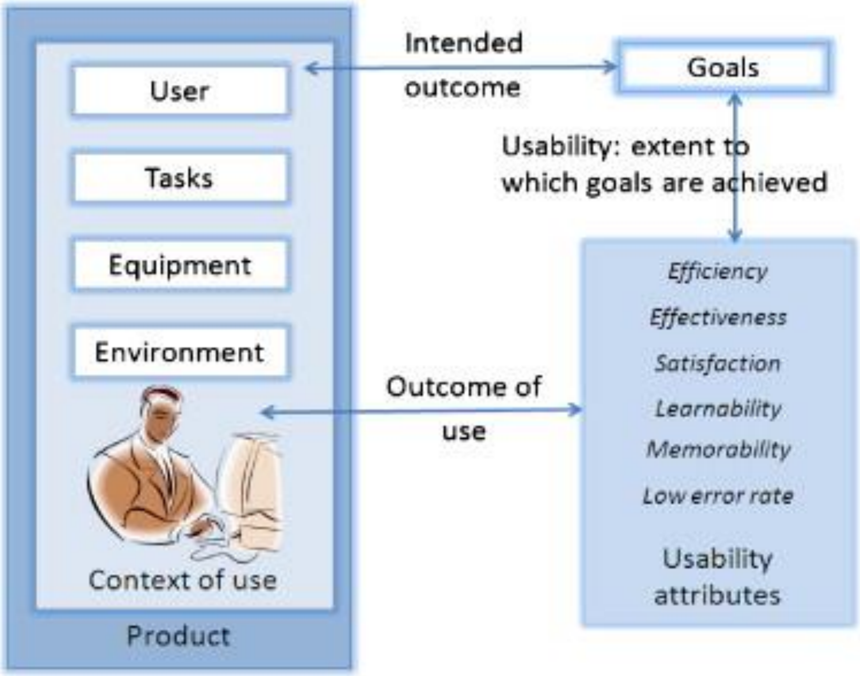

Figure 6: ISO 9241-11 Usability components

(Nielsen, 1993)

Together with Gould et al. (1991), the ISO 13407 standard (1999) describes general principles that characterise UCD: these principles are:

- Appropriate allocation of functions between users and technology.
- Early focus on users.
- Continuous testing and iterative design process.
- Multi-disciplinary and collaborative design.

Therefore, planning for usability as part of the design and development of systems involves the systematic identification of requirements and verifiable descriptions of the context of use. Accordingly, the four user-centred activities to be fitted into the overall development process are:

1. Understand and specify the context of use.
2. Specify the user and organisational requirements.
3. Produce design solutions.
4. Evaluate designs against requirements.

The phases above should be iterated until the system in question meets the requirements.

Generally speaking, the ISO 13407 standard is intended to provide general guidance for the planning and management of UCD, not to incorporate detailed coverage of the methods and techniques. Although the standard specifically applies to office work, the contents of usability guidance are also said to be applicable in other situations where a user is interacting with a system to achieve goals.

Since Human Computer Interaction explains interactions between people (individuals and groups) and computers (stand-alone and networks), the concepts, approaches, techniques and tools of Human Computer Interaction are relevant to website design (Leventhal and Barnes, 2007; Nielsen, 2003). However, the web is unique because of several factors, such as being globally accessible, platform and device independent, flexible to meet personal interests, it has no boundaries, is rapidly evolving and the most important heterogeneous groups of users are using the Internet.

In order for a specific system's usability to be maximised to its full potential, it is vital that a website's purpose is clearly defined, so that the particular attributes of the system can be identified. This purpose has to incorporate the application domain tasks; that is, the work involved which the system is built to maintain. Such groups of tasks are best taken into consideration in the form of significant sequences or use scenarios (Carroll, 2002). These use scenarios need to be considered within the social and organisational work contexts (Rogers et al., 2007). The design procedure should also take into account the attributes of the system's users. A user-centred method involves the examination of the vital attributes of the users in regard to their impact on the performance of appropriate use scenarios (Rogers et al., 2007).

Such knowledge is also necessary for the design of a useful process for the formative evaluation of the usability of a system, in a prototyping cycle (Ferguson and Frydman, 2004; Rogers et al., 2007). The philosophy of The UCD incorporates three main beliefs: (i) concentrate on users and tasks; (ii) empirical assessment of product usage; and (iii) iterative design, where the product in question is developed, altered, and tested repetitively.

Krug (2000) claims that the design for usability is surely neither rocket science nor brain surgery but is very much dependent upon general logic. With the emphasis on users, Pearrow (2000) discusses website usability and explains that web applications are mainly enhancing or substituting conventional transaction paradigms. Krug indicates that web applications are user interfaces which serve as users' access to the web services. Krug states that the objectives of UCD are ease of learning, ability to remember, productivity, low rates of error and high level of user satisfaction. Therefore, the web application design should maintain these key attributes of usability.

Web system designers and developers are challenged to comprehend user tasks sufficiently well in order to provide high-quality hypertext links pertaining to a particular task. This is to inform users what they expect to see after clicking on the hyperlink, although the appropriate destination may be three or four clicks away from the home page. For example, a hyperlink stating 'click to download' indicates clearly that users should expect to find the downloadable materials for which they are searching (Rogers et al., 2007). In this instance, users need not make a conscious effort to think about the technology and can concentrate on their objectives.

Irrespective of the nature of any particular intended interaction item, when the score is given for usability, the following common dimensions should be carefully considered:

- Can users use an item to perform a specific task?
- Will the users feel comfortable while performing the task?
- Has an appropriate usability approach been applied to aid positive perception of the item in question?

The main challenge for information system design in the e-Health information systems domain is to interconnect the medical, technical and social contexts. Hersh (2009) argued that organisational, contextual user, and technical aspects should be studied to extract the key requirements for e-Health information system design. The challenges remain in identifying aspects of the e-Health information system context that need to be taken into consideration when designing patient-centred systems. In broad terms, a hospital context of use is characterised by dynamic working environments that employ alternating practices and several medical technology applications. In a hospital context, staff are considered to be heterogeneous, with a diverse range of skills and experiences. However, in a user context, the picture is entirely different, as the contexts in which users or patients use e-Health information systems to check symptoms or seek medical information or advice are rather different. The following sections will discuss the elements of context of use: users, tasks, equipment, and social environments in which a product is used or is intended to be used.

2.3.1. Interaction Design

Rogers et al. (2007) defined interaction design as designing interactive products to support people in their everyday and working lives; they further argued that a poor interaction design system, especially in e-learning processes, cannot improve in usability by merely changing its graphic interface. Interaction design aims to develop interactive systems that are easy, effective and enjoyable to use from the user's perspective, thus enhancing user satisfaction, which positively impacts on the overall performance. As information technology has rapidly evolved over time, successful interaction design requires expertise from a multitude of academic disciplines, design practices and interdisciplinary fields that are concerned with researching and designing user-centred systems. The combination of human factors, cognitive engineering and computer-supported, co-operative work fields is considered to be crucial for understanding how users react, interact and communicate (Esteves and Andrade, 2011; Nebe and Paelke, 2009; Seffah et al., 2005). These multi-disciplinary fields have related academic fields such as ergonomics, informatics, engineering, computer science and psychology. Nonetheless, understanding how to design different types of interactive systems in effective and aesthetically pleasing ways has also yielded the need for a hybrid contribution of various stakeholders from the above-mentioned fields, although it is agreed that each field naturally has a different focus and methodology (Rogers et al., 2007).

Any communication between a user and a computer is defined as interaction (Rogers et al., 2007), and can be either direct or indirect. Direct interaction involves a dialogue with feedback and control during the execution of a task; in other words, where the user is constantly providing instructions to the system and receiving feedback. The interaction required to use websites is a common example of direct interaction. In contrast, indirect interaction may involve background processing (Rogers et al., 2007; Seffah et al; 2005).

2.3.2. Usability

The ISO 9241-11 standard defines usability as "*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (Leventhal and Barnes, 2007, p. 27). Usability is defined as the simplicity, flexibility and ability of using and learning, and the satisfaction of the user, derived from carrying out specified tasks in any type of setting (Seffah et al; 2005; Nebe and Paelke, 2009; Leventhal and Barnes, 2007) in an efficient and effective way.

Using computers to complete tasks always results in needing to perform at least one functional as well as one operational task simultaneously (Leventhal and Barnes, 2007; Rogers et al., 2007). Functional tasks relate to the content of the problem at hand, whilst operational tasks refer to the means of solving the problem. Consequently, these two tasks will compete for cognitive resources, thus resulting in degraded performance of one or both of them, and of the interaction overall (Bandyopadhyay et al., 2000; Nielsen, 2003; Nebe and Paelke, 2009). Therefore, the most obvious way of enhancing performance is to design systems that will reduce the amount of cognitive resources required to complete both operational and functional tasks (Leventhal and Barnes, 2007; Becker, 2002).

The above definitions emphasise four aspects of designing for usability: (i) concentrate on the users; (ii) recognise that users make the most of products to achieve goals; (iii) be aware that users are attempting to achieve goals despite their busy schedules; and (iv) enable users to make the final decision about the user-friendliness of the product.

Good usability is when users are not aware that they are operating an interface to carry out a desired task or, if they are aware of the interface, they remember the pleasure in using that interface. Poor usability is when they become aggravated and the approach or the interface appears to be an obstacle to carrying out a task (Leventhal and Barnes, 2007). Despite the aforementioned, no one definition of usability is universally acknowledged, although there are a basic range of characteristics that can be extracted from several definitions (Heim, 2008).

From another perspective, Nielsen perceives usability as a value trait of the ease of use of user interfaces. In general, usability is not actually an unusual ‘supernatural’ topic that is complex or isolated, It is what we exist with and labour with all the time. Nielsen summarises good usability as being embodied in a website that is straightforward to learn, simple to recall, efficient to operate, comprehensible, and which provides contentment to users (Nielsen, 2003).

Usability can be broken down into various aspects, such as learnability, effectiveness, flexibility and user satisfaction/engagement (Nielsen, 2003; Leventhal and Barnes, 2007). According to these authors, the purposes of usability components could be listed as:

- Ease of learning: how fast can a user who has never previously seen the interface learn it sufficiently well to accomplish basic tasks?
- Efficiency of use: once an experienced user has learned to use the system, how fast can he or she accomplish tasks?
- Memorability: if a user has used the system before, can he or she remember enough to use it effectively the next time or does he or she have to start from the beginning and relearn everything?
- Error frequency and severity: how often do users make errors while using the system, how serious are these errors, and how do users recover from them?
- Subjective satisfaction: how much does the user like using the system?

Users

Users of e-Health information systems are heterogeneous, as their social environment, skills and needs substantially differ. They could be professionals, patients or others. By default, clinicians and nurses are the main users of current medical and e-Health information systems such as EHR, Clinical Decision Support Systems, and other applications.

Secondary users such as other care workers, healthcare administrators and researchers use different types of e-Health information systems for various purposes. Today, patients and other users are also considered as healthcare technology users, but due to various policies and regulations their access to these systems appears to be very limited. The rapid development in the e-Health information systems domain has the potential to provide alternative means to various stakeholders in the domain. However, users are still distant from being able to access their own medical records online.

A critical aspect in developing and integrating successful applications is to understand who the potential users are, how they behave, and what they need. Early focus on users and continuous testing is one of the key principles of The UCD (ISO 13407, 1999; Gould et al., 1991). user-centred processes try to include the actual users in the development process at the earliest possible time in an effort to produce systems that correspond to the needs of the users and the restrictions of the context of use. The principle suggests that the potential users and their tasks can be directly linked to the development process: they can have an influence on the design as it emerges and solutions can be evaluated by those who are actually going to use the system.

In the field of user-centred design, the concept of user research is used to refer to a process and associated activities that aim to understand the impact of a design on an audience (Kuniavsky, 2003). Observing real or potential users acting in a specific context of use reveals problem areas to product designers and often provides clues to addressing the problems. When conducting user research, it is recommended that several research methods be used in order to obtain rich data and build a holistic view of the studied user group and context of use (Beyer and Holzblatt, 1998). The most common methods used include interviews, observations, and questionnaires (Hackos and Redish, 1998), with other methods such as cultural probes (Gaver et al., 1999) or artefact analyses (Beyer and Holzblatt, 1998) being applied less frequently.

Characteristics of the healthcare domain raise challenges for healthcare ICT development: along with user requirements, other requirements (e.g., medical, technical, legal, and organisational) also need to be taken into account. In several aspects, users who are working daily in hospital environments can be considered as experts: they have the practical knowledge of which things work and which do not, how tasks are performed, which medical aspects need to be considered, and what are the organisational manners. Often, developers do not have in-depth understanding of these conditions; therefore, it is extremely important to involve the potential users, healthcare professionals with expertise in a variety of medical areas, in design activities in several phases of development.

The first challenge for the early involvement of users is to identify and select potential user groups for which the technology will be developed. The second challenge can be seen as an opportunity: harnessing the users as a driving force for the innovation. The ideas of ‘open innovation’ (Chesbrough, 2003) and ‘user-driven innovation’ (von Hippel, 2001) have been presented to involve the users in innovation and thereby ‘democratise’ the innovation work and the production process. In addition to early focus on users, the principle also emphasises the need for continuous testing with users. Continuous testing indicates that small iterative tests on prototypes may be sufficient to meet user needs without lengthy usability testing at the end of the design process (ISO 13407, 1999). Pressman (1992), Nielsen (1993) and other researchers have argued that, for each phase of development that proceeds without formal usability testing, the cost of fixing usability problems increases considerably.

In general, usability evaluation is considered as being an essential part of the UCD process. Evaluations should take place at all stages in the system’s lifecycle in order to influence the system's development (ISO 13407, 1999). As the ISO 9241-11 standard (1996) indicates, the context of use needs to be taken into account in design as well as in evaluation. Usability evaluation methods can be divided into empirical user testing and usability inspection without user involvement methods (Nielsen, 1993). Usability testing, in which a participant performs given tasks with the system being evaluated, is probably the best known and most commonly used method to evaluate user performance and acceptance of products (Nielsen, 1993). For the reason that different evaluation methods serve diverse evaluation purposes and reveal different problems, different methods should be used as a complement to each other.

Tasks

The task context considers all characteristics of the task that could influence the user while using the computer to perform that task (Leventhal, et al., 2007). A task is considered to be an activity that starts from an initial known state of the human, the computer or the environment, and continues until it reaches a known end state (Chamorro-Koc, 2008).

It is noticeable that there has been a surge in those Internet-based health applications that allow users to check symptoms and obtain health information. Users access the health application online (through PCs or mobile devices) and then they search for symptom definitions (information retrieval) and their related diseases. Users can also diagnose themselves through online diagnostics tools, check their Body Mass Index (BMI) and Basal Metabolic Rate (BMR), etc. Such functions require the employment of various interaction techniques (Reuss, 2007a) and, with the infiltration of online social media, users can also interact with other users and discuss chronic diseases.

Users' concern for their personal health and wellbeing is the driving motivation for their actions; they may also want to support friends or family members. Rotondi et al. (2005) describe users' health behaviour in relation to two variables: the psychological state of readiness to take specific action and the extent to which a particular course of action is believed, on the whole, to be beneficial in reducing the threat.

Equipment

Contrary to hospital settings, the environment that surrounds users is equipped with rather different applications than those used in hospitals or healthcare workplaces. Advanced computer-powered devices in the field of e-Health information systems have reshaped health services dramatically. A wide range of those devices and online systems are designed for personal use. This includes patient health records, blood pressure monitors, glucometers, etc. (Hackbart et al., 2004). These devices, however, lack patient-centeredness and are designed based on Western culture, without due consideration to other cultures.

Environment

According to the ISO 9241-11 standard (1996), environmental components include:

- The physical environment, such as workplace, equipment and furniture.
- The ambient environment, such as temperature and humidity.
- The social and cultural environment, such as work practices, organisational structure, and attitudes.
- The attributes of the wider technical environment.

Yazdanfar and Aghili (2012) established that users access the Internet in their leisure time, while health practitioners or physicians uses the Internet in their workplaces. This indicates that the environments in which e-Health information systems can be used vary significantly.

Hospitals and clinics environments are intensive, as the amount of processes, activities, and communication amongst staff is expected to be very high; however, the settings inside a hospital can be recognised, for example, most hospitals will have wards, operating rooms, clinics, accident and emergency department, etc. Contrary to the hospital environment, the patients' environment is impossible to describe or quantify, as, for example, portable medical devices such as the glucometer and mobile smartphones can be used anytime anywhere.

One school of thought contends that acceptance is not associated to usability as defined in the usability engineering literature, because usability tends to be a performance-based concept (Bandyopadhyay and Fraccastoro, 2007). The primary concerns in relation to usability include the number of errors made by users, the amount of time that users take to complete a task, and the percentage of users who are able to successfully complete tasks. In contrast, TAM predicts user opinions about a product before the product is actually used. In most of the research on this model, the focus has been on understanding the links between intention to use and Actual System Use (ASU). A typical experiment used in the TAM research involves demonstrating new software to a user, and then asking the user to make value judgements about whether or not s/he is will use the product, based on her/his perceptions of its usefulness and ease of use. This approach does not allow for usability in terms of accuracy and speed to be measured because the user has not yet used the product. In addition, it has been argued that more meaningful perceptions of usability are developed only after the user has had hands-on experience with the product (Venkatesh and Davis (2000). In this situation user acceptance, or attitude, towards the product, can be described as the user's perceived usability of the product (Davis, 1989, 1993). User acceptance in the TAM literature is therefore belief-based, in that it is based on the users' perceptions of usability. Thus, the main argument against the relationship between user acceptance and usability is based on the differences between perceived usability (belief-based) and actual performance (performance-based) (Bandyopadhyay and Fraccastoro, 2007).

The definition of usability as stated in the ISO 9241 standard (1997) indicates that usability is both a belief-based and performance-based concept. Effectiveness and efficiency are undoubtedly performance-based concepts, in that they are measured in terms of actual performance. Satisfaction is defined by this standard as the comfort and acceptability of the system by its users. Measures of satisfaction may relate to specific aspects of the system or may be measures of satisfaction with the overall system. Bietz et al. (2001) argued that users develop a value judgement about their level of satisfaction with a specific system characteristic. Overall customer satisfaction is then developed based on an aggregate of the satisfaction levels with the various system characteristics.

Differentiation between usability goals and user experience goals allows for the identification of two categories of valid, measurable usability parameters, namely objective usability and subjective usability (Bailey, 1996). Objective usability measures assess how capable users are at using the system, and include measures related to effectiveness and efficiency. Subjective usability assesses how satisfied the users are with the system, and includes measures of acceptance and comfort. The technology acceptance literature shows that, if users are satisfied with the perceived usability of the system, they will accept the system (Davis et al., 1989; Venkatesh and Davis, 2000, 2008; Akour et al., 2006; Khushman et al., 2009), thus indicating that the system is subjectively usable. From the above-mentioned explanation, it is evident that user acceptance is related to usability in terms of subjective usability measures.

Bevan (1995), one of the authors of the ISO 9241 standard, explained that measures of satisfaction describe the perceived usability of the overall system by its users and the acceptability of the system to the people who use it and to other people who are affected by its use. Measures of satisfaction can provide a useful indication of the user's perception of usability, even if it is not possible to obtain measures of effectiveness and efficiency. Satisfaction is therefore a belief-based concept that assesses the users' perceived usability of the system, which suggests that perceived usability is a valid measure of usability.

2.4. Related Work

2.4.1. Patients’ e-Health Targeted Systems

Personalising the interface to fit the user has long been acknowledged as important by either the industries that develop the software or the outlets that use the Internet to market their products. The stakes are very high in such fields; however, it is noticeable that the system development houses limit the personalisation into a localised version of the system interface, which is known as the national culture interface. The national culture interface in the context of this research is perceived as how people relate to, work with and come to understand and accept technology. In this way, national culture could be used as a context or frame of reference with which to understand the differences emerging between countries in the use and perception of e-Health information systems. The country’s national culture could be used as a foundation to set the initial parameter for interface personalisation for people related to that culture. This approach is not user targeted; rather, it is country targeted. However, the emphasis should be on tailoring systems that can customise the interface to suit individual users’ needs (Kumar et al., 2004).

A considerable number of user-oriented studies have concentrated on the later phases of healthcare ICT development and evaluated the usability of a system already in use. Typically, evaluation studies have focused on e-Health information systems, particularly EHRs, and their use in clinical settings (e.g., Walldén et al., 2007a; Walldén et al., 2007b; Kjeldskov et al., 2008). However, examples of other kinds of evaluations can also be found. For example, Kushniruk et al. (2005) studied the usability of a handheld prescription-writing program. Most of the evaluation studies have applied traditional usability evaluation methods: usability inspection methods (e.g., Pohl et al., 2007; Becker, 2004) and tests with users (e.g., Nunnally et al., 2004; Kjeldskov et al., 2008; Peters et al., 2009). In contrast, studies by Giménez-Pérez et al. (2002) and Walldén et al. (2007) have presented slightly different approaches.

Darbyshire (2004) indicated less positive experiences. He used a qualitative approach and focus group method in the research. According to his results, nurses' experiences were characterised by digital disappointment rather than electronic efficiencies. Nurses felt that computerisation had neither enhanced their clinical practice and patient care, nor had it improved patient outcomes. Studies about healthcare workers' attitudes to healthcare technology personalisation have shown that physicians may be reluctant to accept implementation of an IT system that interferes with their traditional routines. Chau and Hu (2002) investigated physicians' decisions to accept healthcare ICT, and concluded that with regard to technology acceptance this group of healthcare professionals appears to be fairly pragmatic, concentrating on the technology's usefulness rather than on its ease of use. Furthermore, the physicians seemed to be relatively independent in making technology acceptance decisions, for instance, not attaching much weight to suggestions or opinions from others.

The studies by Moody et al. (2004) and Darbyshire (2004) are not the only ones reporting mixed findings. Jensen and Morgunn (2007) also reported both positive and negative attitudes after studying the adoption of EHRs among surgeons. Altogether, several literature reviews have confirmed mixed results (e.g., Häyrinen et al., 2008; van der Meijden et al., 2003).

For example, Nguyen et al. (2012) investigated the challenges facing the development of e-Health in Vietnam, as the government strove to deliver effective and efficient e-Health services for the 'end-users', where the current focus was the implementation of a patient-centred e-Health system. Some public and private initiatives launched electronic record management systems, such as Medisoft, and another 10 EHR systems which provide different functionalities were implemented. According to the authors, EHR packages were recently integrated to a number of computationally empowered mobile devices in an effort to increase user access to EHR. Nguyen et al. (2012) briefly discussed the deployment of 'yClinic SE 2008', which is a Vietnamese development that is designed specifically for outpatient EHR. yImage and yRadiology are yClinic's components that allow the diagnosis and treatment of patients, while yHospital is a hospital management system. Other systems for teleradiology, teleconsultation, telediagnosis and video conferencing were also deployed to further aid the patients' treatment process.

Despite the several attempts to lure Vietnamese patients and clinicians to use EHRs, their usefulness and reliability are not yet acknowledged, as the majority are still using paper-based health records. In an attempt to shed some light on technology adoption amongst the Vietnamese, Nguyen et al. suggested that language and cultural beliefs constituted the major barriers that negatively affected EHR and other e-Health systems' adoption.

Shash et al. (2013) conducted a study to identify factors that influence the patients' use of a point-of-care medical device, a 'coagulometer', for self-testing of the International Normalised Ratio (INR). To achieve their aim, the authors employed TAM in cross-sectional settings, through the administration of a self-completed questionnaire. One hundred and twenty-five outpatient records were analysed through various statistical methods. The majority of the participants were males aged above 70 years; they were all anticoagulation outpatients for INR testing. The findings indicated that only two patients were using the portable coagulometer through INR testing; the majority (84%) stated that they were not aware that such a device existed. The statistical analysis results indicated that there are direct significant predictors that influence patients' intention to use INR self-testing: in this case, the significant factors were technology perceptions, trust, and affordability. The results also indicated that trust in a doctor significantly affected technology perception, as well as age, and affordability. They also concluded that patient's age, cost of the device and overall INR device perception were the main determinants of patients' intention to use the INR-based portable coagulometer.

Shash et al. (2013) argued that factors that affect the intention to use INR portable medical devices are unique to the portable devices, and are not like other factors that might affect acceptance of other technologies. The authors concluded that patient's age, cost of the device and overall INR device perception are the main determinants of patients' intention to use the INR portable coagulometer.

Although the study yielded some statistical significance, the fact that the sample was small, only 125 participants, undermined the legitimate use of multivariate analysis techniques (Pallant, 2010; Tabachnick and Fidell, 2007). It is also notable that the majority of the participants were over 70 years old. For that age range, there is expected to be this notion of rejection, as the level of computer literacy is expected to be very low. The study would benefit from having more young and middle-aged participants, as they are expected to be more technology friendly. The aforementioned limitation questions the applicability and validity of the study if the findings are to be generalised across home-based medical devices

Valdez et al. (2012) produced a culturally informed e-Health design framework which consists of four dimensions that define a consumer health IT system in a cultural context. The choices designers make in these four dimensions are likely to influence the usability, acceptability, and effectiveness of a consumer health IT system for a given culture. The four dimensions are: 1) technology platform, 2) functionality, 3) content and 4) user interface. The technology platform refers to the type of hardware; the functionality refers to the types of actions that may be performed; the content refers to the message being delivered; and the user interface refers to the presentation and organisation of the content and functionality.

Valdez et al. (2012) further elaborated that within engineering there has been a growing understanding that designers must understand and design for the cultural context within which their intended users are embedded, and that cultural factors can no longer be ignored.

Valdez et al. (2012) concluded that their framework should be useful in helping designers conceptualise the dimensions of a consumer health IT system that is likely to require cultural tailoring. Design choices made in their framework dimensions are likely to influence and constrain the types of design choices that may be made in another dimension. Thus, it is important that their framework be used within an iterative design process to ensure that all dimensions of a consumer health IT system are appropriately culturally informed. Furthermore, their framework is descriptive in nature; it does not provide designers with guidelines in the form of cultural classification and technology design orientation.

Piras et al. (2010) proposed a structured design process to prototype a Personal Health Record (PHR), which is supposed to be patient-centred. They focused on health-related activities carried out by patients in their homes. Their approach was rather sociological, which will help elicit requirements of the health information system for in-house care through their data collection, which included observation. The authors identified three unique concepts (zero effort, erratic, networking), and mapped ‘translated’ them into possible ‘measurable’ design elements (flexibility and personalisation), and argued that the key to such PHR success is its capability to support the existing activities carried out by patients in managing their health records.

Mon et al. (2007) investigated cross-cultural factors that enable the design and development of a flexible e-Health information system for consumers, and argued that dissemination and diffusion of consumer e-Health information systems across various societies and cultures requires "*explicit attention to design and development process*". They based their arguments on Berg's (1999) work, where the importance of exploring the interwoven" nature of heterogeneous groups of people's "routines, resources and responsibilities was thought to form consumer e-Health information systems' context of use. Mon et al. (2007) claimed that such bases would enable the move from 'sociotechnical' to incorporate 'sociocultural' factors in the design process.

Haslina and sharifah (2006) discussed issues surrounding the acceptance of the Electronic Medical Record (EMR), stressing the importance of acceptance study in the field of e-Health. They argued that there is a need for a social framework for EMR acceptance. Factors such as user behaviour, perceived ease of use, perceived usefulness, information quality and interface were all investigated, and found to be of great concern. This highlighted the need for an investigation into the acceptance of EMR among doctors, nurses, clinicians and patients before EMR can be successfully implemented.

2.4.2. Technology Acceptance

Tarhini et al. (2015) extended the Technology Acceptance Model by incorporating additional factors namely Subjective Norms (SN), Quality of Work Life (QWL), Self-Efficacy (SE), Actual Usage (AU) and Facilitating Condition (FCs) to explore the extent to which these factors influence students' intention to adopt e-learning applications.

Tarhini et al. claimed that their results confirm the ability of TAM to be a useful theoretical framework for better understanding the students' acceptance of e-learning technology. Their results suggest that the majority of United Kingdom participants and the Lebanese sample expressed a positive intention towards e-learning systems. The integration of SN, QWL, SE and FC factors into their investigation suggested that PEOU, PU, SN, QWL and SE were influential predictors of behavioural intention and the adoption of e-learning applications, with QWL as the most significant. Tarhini et al.'s study suggested that there was no significant variance between the United Kingdom and the Lebanese participants' views in terms of AU, QWL, SN and PEOU of e-learning adoption. Their results further indicated that there are no differences between the Lebanese and the United Kingdom participants' views in terms of PU and BI, although differences were found in terms of PEOU, SN, QWL, FC, SE and AU.

Their results indicated that Perceived Usefulness was the most significant contributor to the participants' behavioural intention to adopt e-learning applications. SN, SE and FC were found to be significant determinants of the behavioural intention and the AU of e-learning applications for the Lebanese participants. They argued that participants who possess a higher self-efficacy perform more active learning.

Their findings suggest that individual, social and organisational factors are important to consider in explaining students' BI and usage of e-learning environments. However, they concluded that transferring such technologies to a different cultural setting might not have the same significance. They also concluded that participants who find that an e-learning application is useful to them, and is easy to use, are more likely to adopt it. Tarhini et al. suggested that practitioners should design contents that are of high quality and are up to date and easy to access in order to promote the adoption of e-learning applications.

Like many authors in the field of culturally-aware information systems design, Tarhini et al. considered Hofstede's cultural dimensions to be true and accurate, which to a great extent affected their results as Hofstede's study was conducted in 1984. Nevertheless, the fact that the study employed a self-reported questionnaire and was not reporting an actual e-learning application's results affected the validity of their results; therefore, it would be difficult to generalise from their findings.

Khushman et al. (2009) presented a Culturally Sensitive Technology Acceptance Model aimed at being a useful tool for organisations to understand the determinants and factors (particularly cultural factors) that influence users' acceptance of e-Business. They argued that their study would enable organisations to develop targeted websites that would attract more users, and also argued that understanding of cultural influences, such as subjective norms and tangibility, on website acceptance could enable better utilisation of social systems to facilitate website acceptance. They further stated that e-business website quality could then be modified to improve compatibility with the cultural tendency of the organisations or individuals involved. Khushman et al.'s (2011) their model provides culturally adjusted information explaining website usage, which will make it easier to market and promote Jordan and other Arab countries as a tourist destination. Although the study provides a useful insight into the applicability of TAM in the field of e-Business across UK and Arab cultures, it was based on the first version of Davis' (1989) TAM, which has been greatly affected by ignoring the impact of cultural factors. Davis' TAM was then later enhanced by incorporating three categorical external factors (Venkatesh and Davis, 2000, 2008), which boosted the reliability of the model; thus, Khushman's et al.'s reliance on a model that is 'out-dated' raises many questions concerning the validity of their study. Nevertheless, despite the fact that their study was investigating website acceptance, initial consideration should be given to the usability aspects of the interface design; this again has been neglected in the study, which will undermine the quality of the results.

De la Cruz et al. (2005) investigated cultural influences on website quality and evaluation factors, and used a questionnaire to sample 350 Internet users from Peru and Germany. The results indicate that the features of website quality differ between those two cultures, although the analysis failed to explain the results based on Hofstede's (1984) cultural dimensions. The authors argued that there is no Internet international culture and that local cultures still influence user attitude and behaviour.

Kim and Park (2012) employed consumers' health behaviour intentions to develop a health information technology acceptance model, namely the users' behavioural intention to measure and store, and the willingness to manage their own health data, which have been integrated into an extended technology acceptance model. They argued that such expansion will enhance the model's explanatory power and to make it more applicable to health consumers' behavioural intention in their methodology, and pointed out that they had collected 728 samples through Korea's Internet health portal structured, self-administered questionnaire. The authors employed various statistical techniques to analyse the data and to establish facts related to their claimed model.

Kim and Park (2012) results indicated that perceived threat, perceived usefulness, and perceived ease of use are of statistical significance and do influence consumers' behavioural intention to adopt health information technology. Nonetheless, consumers' health status, subjective norm, health information technology characteristics, and self-efficacy all indicated a strong indirect influence on attitude and behavioural intention, which was mediated via perceived threat, perceived usefulness, and perceived ease of use. Again, this study lacks the employment of HCI and cultural representation.

In summary, although the above attempts provide a good insight into technology acceptance in various settings, they all fail to give serious consideration to HCI and in particular interface usability implications on technology acceptance. Nonetheless, the fact is that most of the e-Health information systems applications have originated from America and Europe without due consideration of foreign user behaviour, metaphors, cultures, environments and motivations. As a result, such applications can be difficult for users who are from different cultural or geographical zones to adopt. This highlights the need for a study that combines Technology Acceptance, cultural dimensions, HCI and e-Health information systems to produce a framework that bridges the gaps in the above-mentioned studies, and provides grounds for future patient-centred, culturally-aware e-Health information systems.

2.4.3. The Diversity of Users

Many studies have investigated the issue of globalisation and localisation of the system content. People from different countries have different cultures and unique ways of interaction and behaviours. Therefore, Information systems users prefer various interface characteristics that meet their different needs in terms of navigation, density of information, security, product information, user service and other features.

Song and Zahedi (2001) developed a conceptual framework for exploring the differences in how users from diverse cultures and with different individual characteristics might use system documents. Song and Zahedi (2001) claim that the framework is for the system but focuses on text alone. This is only one aspect of several in Song el al. design, so it is difficult to generalise their framework.

Up to now, HCI designs were often realised without considering the abilities and needs of this user group. Zajicek and Hall (2000) state that perceived usefulness of a technology is lower in older adults, because they weigh the perceived usefulness against the time needed to learn how to operate the system. Related to this balancing procedure; is the fear of failure as an additional cost, which much more pronounced in older adults (Wilkowska and Ziefle, 2009a; Melenhorst et al., 2001, 2006).

Chang and Su (2012) conducted a study in Taiwan investigating the perception and effectiveness of a localised version of an e-learning interface, as well as studying the users' attitudes towards the system. Chang and Su (2012) stated that interface internationalisation is the process of designing systems that maybe used effectively by a heterogeneous cultural group of users, while localisation is the mechanism of incorporating culture-related elements into the system to be able to adapt to a region's specific language or culture. Their study assessed the significance of culture in system usability and acceptability, and examined then compared the localised version of the interface to a non-localised version to find whether using localised interface designs would make a difference compared to a non-localised one in terms of users' learning outcome results. Their study also assessed the impact of interface localisation on users' perception of interface design in particular, users' satisfaction and the system's efficiency.

Chang and Su (2012) results suggested that users are of a neutral opinion regarding the localised interface layout in relation to the look and feel of a system. The majority of the participants showed neutral opinions when asked if the localised interface could better convey cultural significance. Chang and Su (2012) concluded that interface localisation did not influence users' acknowledgment of the cultural representation, however, the users failed to recognise that the localised interface is "*a better representation of their cultural heritage*" and that the localised interface did not report any significance in terms of the system's usability, adaptability and culture-ability.

Chang and Su (2012) study affected by the static nature of interface localisation, although it "*to some extent*" represented the culture. However, culture is known to be dynamic and not static in nature (Erez and Gati, 2004); hence, users from the same cultural boundaries might react differently to the interface localisation technique. Nevertheless, the fact that the localisation and the adaptation processes were developed based on the researchers' assumptions and was not based on the users' requirements and understanding of localisation negatively impacted on the outcome of the study. The researchers would benefit from a piloting strategy where the data is first collected to aid the understanding of the factors that might influence the interface localisation acceptance, and then a dynamic interface is developed that customises itself according to the user's preference rather than being based on the national culture. This process will likely increase user satisfaction, and hence impact the overall acceptance of the interface localisation.

Singh and Pereira (2005) stated that understanding different cultures is the main barrier to extending globally, thus health organisations should work to overcome cultural barriers and language differences on the interface. Many researchers studying systems development have stressed the importance of a localised global system interface, as this will attract and retain more users. Some (Tsikriktsis, 2002; Luna et al., 2002; Stengers, et al., 2004; Singh, et al., 2015) have stated that the localisation of an interface includes translating information content and modifying graphical and visual elements, content and examples to make them culturally acceptable.

According to Luna et al. (2002), culturally congruent interface content helps users to use the system and decreases cognitive effort to process information on the site, and represents an environment where demands are clearer, leading to easier navigation and favourable attitude toward the web site. This is because the processing of information is linked with cognitive schemas, which help people to store information in specific categories (Nantel and Glaser, 2006).

Singh and Pereira (2005) analysed 93 interfaces from local health organisations in China, India, Japan and the USA to investigate the effect of cultural values on international interfaces. The results showed clear correlations between the cultural content of the interfaces and the cultural dimensions established by Hofstede (1984). Singh and Pereira (2005) indicated that marketers and global health organisations should localise their interfaces to enhance and increase system efficiency. However, although the research provides evidence of cultural differences in system content, it has some limitations as, for example, the sample was not representative.

In addition, Marcus and Gould (2000) tried to build localised interfaces for national cultures by using Hofstede's study, and believe that Organisations should consider the impact of culture on the understanding and use of Web-based communication, content and tools.

In terms of system design, many different features should be considered, such as menu layout, access to product information, professional design, screen design and navigation. These features may differ between cultures; for example, navigation of Arabic interfaces should be right to left, while, in English, it is the opposite.

Badre (2000) stated that the use of "cultural markers" is important when personalising an interface to a specific culture. He listed the following interface design elements: colour, spatial organisation, fonts, shapes, icons, metaphors, geography, language, flags, sounds, motion, preferences for text vs graphics, directionality of how language is written, help features, and navigation tools.

From the above-mentioned, it can be concluded that the cultural dimensions' aspect focuses on identifying the thinking, reaction and feeling patterns that form our cultural mental model, which suggests that the cultural dimensions to some extent influence our cognitive ability to perform tasks, which in turn influences our problem solving and reasoning approach. Hofstede's theory is therefore considered to be suitable as one of this research's foundation pillars, where we are investigating the impact of including culture as one of the design factors.

Nantel and Glaser (2008) argued that culture is an important factor to be taken into account for evaluating websites as they are part of any evaluation, regardless of the targeted audience. It is important that health organisations consider the cultural aspects of their target segment to understand them, stressing common points or explaining local culture in terms that relate to the source culture and therefore are easier to understand and probably more sympathetic to the receiver.

Cranor et al. (2000) produced three golden rules for website design and implementation. These rules state that the user or users should be able to find the online information; understand the online information; and feel comfortable about the way it is presented. These rules support three important issues that should be considered when health organisations target international users: that e-Health information systems should be found easily through search engines, use understandable language and content for the targeted users, and, finally, make users feel comfortable while using the application.

Some studies have proposed that graphic and iconic representations are not universally realised and understood, as they are culturally learnt (Evers, 1997; Badew, 2000). Some graphics, symbols and images may offend one group of users on cultural or religious grounds. Yeo and Barbour (1996) commented that user-preferred classification schemes change within cultures, dependent on the attributes of the user's country.

Another important issue that should be considered is the navigation around the website. Users from different countries have different methods of reading: The Arabic language is read from right to left while the English language is read from left to right, and some Japanese and Chinese scripts are read from top to bottom. In addition, navigation of the websites should be natural to each user's culture. Del Galdo and Nielsen (1996) explained that screen design directions have different psychological and social connections in different cultures, and that various users have different concepts of screen usage.

Moreover, there is still little empirical evidence for how consideration of cultural models could improve e-Health information systems design. Many researchers stress the need for more empirical cultural research into the perception and preferences of users towards the Internet and websites (Bourges-Waldegg and Scrivener, 1998; Evers, 1997).

The field of HCI has frequently applied Hofstede's model and to a lesser extent other cultural models to explain, describe or frame the cultural differences found in design. Many studies have looked at two or more cultures, trying to compare them and understand how they vary in interface design and technology use or acceptance. Some of the efforts to apply cultural models to HCI are limited in their scope, either because of sample size or lack of comprehensive testing or verification, and some have produced conflicting results. However, there is a large body of work in the area of cross-cultural HCI which falls into the category of using cultural models as explanatory frameworks.

The first application of culture mentioned, as a generative tool to construct guidelines and design frameworks, has been attempted by several researchers. For example, Yeo and Barbour (1996) proposed a strategy for making local, culturally appropriate (localising) user interfaces. Referring to these interfaces as Cultural User Interfaces, he suggests that the first step is to localise the easily visible elements such as date, time, units of measure and currency formats, character sets and writing direction; and then the interface design would also address the less obvious needs of using appropriate visuals, functionality, metaphors and mental models. Developers and designers would work together with experts from the target culture as a team throughout the software development lifecycle. These teams would make decisions on what parts of the software required localisation, on how best to build the interface, on the system itself and on how to test it with the target population (Yeo, 1996). Since Yeo's call for more culturally appropriate designs, other HCI researchers have developed culturally targeted guidelines and design frameworks for both the front-end interface and the back-end system.

One interpretation of Hofstede's cultural model for HCI is that of Marcus and Gould (2000), who proposed holistic design guidelines. For example, the design recommendations for high power distance (discussed in depth in section 3.5.7) cultures include: (i) access to information should be highly structured; (ii) tall hierarchies; (iii) a strong emphasis on social and moral order (iv) and the use of business and social roles to organise and restrict information.

Marcus and Gould (2002) assessed interface design differences and similarities between various international websites. The results yielded a significant variance between cultures, even when a standardised design that adheres to interaction design principles is applied.

Marcus (2009) analysed some Arab websites originating from Egypt and the UAE. He based his study on the sites' usability markers, in particular the information structure and presentation, metaphors, colours, interactivity, navigation style, icons and images. Marcus' study concluded that there is a lack of user representation. He suggested that those sites need to consider the use of multimedia objects, expressive images, and, more importantly, multilingual contents.

Another approach to providing a cultural design framework is proposed by Smith and Dunckley (2007), who explored how cultural differences that affect website usability and acceptability can be communicated to designers and developers. They had earlier acknowledged that there is a lack in explicit demonstration that such theories of culture are actually applicable to and significant within website usability (Smith and Dunckley, 2004).

Smith and Dunckley (2007) indicated that there is a need for a model that is specifically designed for target users that better fit for the intended target audience and the industry. Their suggestion was to conduct a review of existing sites in each culture to gather design elements important to and appropriate for the audience, which to a great extent is similar to Marcus and Gould's (2000) approach. Their review produced a "*meta-level taxonomy*" that incorporates the use of colour, symbols, linguistic cues, icons, and branding, and stated that all should be culture-specific, while the branding will address the users' trust issues (Smith and Dunckley, 2004). They also produced another measure called a 'fingerprint'. The concept is based around comparing Hofstede's Value Survey Module score against an existing site to determine the cultural suitability of a website.

Smith and Dunckley (2007) approach sounds logical; however, it is a very laborious process, and needs continuous human intervention every time the suitability of a website is to be assessed. Our research will positively contribute to this process by eliminating the need for human intervention. The contribution will be in a form of an adaptation mechanism that will be automatically invoked to customise the interface and the contents to suit the current user.

Ford et al. (2005) suggested a more enhanced way of discussing cultural representation; their model consists of five categorical measures of variables that influence interface usability. Those measures are: subjective culture; the interface; user acceptance; speed of performance; and objective culture. To apply their model, Ford et al. (2005) suggested three contexts: user characteristics, task characteristics and the environment. The user characteristics context is further broken down into three classes: cultural, physical and psychological characteristics. The psychological characteristics class includes several sub-classes, which are investigated using the Unified Theory of Acceptance and Use of Technology (UTAUT).

Ford et al. (2005) included in the users' characteristics perceived enjoyment, professional status, self-efficacy, ease of use, ease of understanding, computer anxiety, and computer self-efficacy. Task characteristics are further broken down into job category, risk, demands, linkages and task execution. The environment category consists of organisational environment, technical environment and physical environment. Each one of the classes under each category is further broken down into specific variable that would need to be controlled, isolated or accounted for in some way when conducting cross-cultural usability research.

While Marcus and Gould's (2000) guidelines address the front-end design and Ford et al.'s (2005) model provides an empirical model for cross-cultural usability evaluation, Kersten et al. (2002), addressed the problem from the back end, and presented a conceptual framework for designing the back-end systems to be more culturally appropriate.

Ford et al. (2005), Marcus and Gould (2000) and Kersten et al. (2002) draw on the models of Hall and Hofstede (among others) to assert that it is not just the interface that is affected by culture, but also the software sitting behind the interface, and argue that culture influences both our core beliefs and behaviours and the way we approach business practice. Applications that appear as 'e-Business', such as online customer services, online banking, etc., are extensions of the social interactions that take place in the real world and are influenced and shaped by the culture of their participants. Thus, the authors suggest taking a more culturally-aware approach to software development. This can be achieved first by determining which aspects of the software are culturally dependent and then designing these separately to be appropriate for each culture, while maintaining a core set of 'libraries' used by all instances of the software (Kersten et al., 2002).

Khushman et al. (2009, 2011) and Venkatesh and Davis (2000) argued that cross-cultural factors are likely to influence construction of timely, tailored and flexible presentation of information, appropriate communication services and access to best evidence for lay people globally. Their culturally-oriented proposal aims to augment the current design” of consumer information systems, which according to them will enhance the current state of consumer focused information systems for two reasons: (i) evolving design strategies would benefit from explicit integration of contextual, culture-specific perspectives that influence consumer information systems design, development and diffusion, and (ii) the current design approach is rather laborious and not efficient to service heterogeneous cultural groups.

2.4.4. Interface Personalisation

One of the challenges of this research derives from the inherent difficulty in modelling users in a way that caters for user-centeredness while preserving their cultural preferences. Our approach is to employ dynamically culturally personalised contents to facilitate such a process, as it ensures that both the interface and contents are fetched onto the screen in a format that suits the users.

Heimgärtner et al. (2008) argued that culture significantly influences interaction design, as the interface will be used under specific cultural contexts. They stated that culturally modelled information correlates to the look and feel of a system, which should not be considered as universal, as each develops its own cultural identifier, which is a subset of one or more national cultures, and which impact the individual’s characteristics, behavioural attitude and values. To serve such diverse individuals, they suggested the use of personalisation to uniquely imprint end users with special needs. They claimed that this would improve usability, lead to less cognitive load and improve the universal acceptability of a system.

They categorised the personalisation and interaction patterns according to the cultural background of the users, in particular design, ‘ample vs. simple’, language, density of information, navigation structure (menu style), and personalisation and interaction devices. They combined various cultural discriminators to enable adaptive systems to automatically detect different cultural imprints and to relate end-users to a certain culturally imprinted behaviour. Their approach to individual adaptation (personalisation) takes into consideration the formation of principles to hold the mental workload at the lowest possible level, and to expand global accessibility. Their adaptation approach is based on statistical methods and semantic processing to extract the individual variables and its values from the interaction pattern data, then analyse and evaluate the data to generate adaptation rules based on neural networks and structured equal models.

Fogli et al. (2010) introduced a mechanism to adapt the interface to suit the users; the approach is based on joining the adapted contents and personalisation of the interface. They argue that such a mechanism can be achieved by the determination of all possible matches between a content assignment and a collection of presentation schemes and by assessing them on the basis of a set of UI design principles in order to predict the highest-quality match. From the literature they derived a set of user-interface design principles specifically focusing on the relations between content and presentation. To employ those principles with interface and contents personalisation, fuzzy reasoning was adopted to represent user interface principles and apply them to the matches between a content assignment and presentation schemes. They argued that this choice proved effective in a number of experiments they conducted. Such an approach is expected to have several advantages such as automation of content presentation, which could lead to the possibility of dynamically generated web pages using the same contents but rather different presentations.

However, their approach was undermined by their negligence of cultural implications on the interface acceptance, as it has been stated above that culture is a crucial factor when it comes to technology adoption in foreign countries. The study was also affected by that the fact that their UI principles were based on the literature rather than empirical investigation, as their approach did not discuss how those rules, which are based on literature, will be updated to reflect the current state.

Reinecke et al. (2011) investigated and introduced an adaptive system, ‘MOCCA’, to customise the interface based on the user’s cultural profile. According to them, MOCCA can customise the interface at the user’s level but not the national level. The user profile for MOCCA is calculated according to a weighted average of the user’s duration of stay at current and former residences. They claimed that their results supported the argument for the need for individualised interface customisation, and that interface cultural adaptation could represent different states of the interface. Their experiment suggests that users’ performance significantly increased from 22% to 69%, where the perceived usability and the attractiveness indicated that the adapted version is considered easier to use and attractive compared to the non-adapted version. They claimed that 66% of users favoured MOCCA's culturally-adapted interface; a similar significant number of users also indicated that MOCCA is more aesthetically appealing, while 56% believe that they could be more productive when using the MOCCA adapted interface. Reinecke et al. concluded that interface cultural adaptation has a central role in ensuring both working efficiently and achieving user satisfaction.

However, the MOCCA adaptation focuses on interface customisation; it does not address the content that goes into the interface. Having a dashboard 'interface' that customises itself but neglect the content customisation will significantly affect the overall efficiency and productivity of the application; hence, MOCCA would benefit from applying the same adaptation principles into the content 'knowledge' design to better enhance its efficiency and productivity.

Hoque and Bao (2015) investigated the influence of culture on the adoption of e-health in Bangladesh; they developed a framework by integrating Hofstede's cultural dimension model and the Technology Acceptance Model (TAM). Their study found that cultural dimensions such as Power Distance, Masculinity, and Restraint had significant impacts on Intention to Use e-Health, whereas Uncertainty Avoidance and Collectivism had no significant impact on Intention to Use e-Health in Bangladesh. The results also revealed that Perceived Usefulness was a significant indicator of e-health adoption decisions, whereas Perceived Ease of Use was an insignificant predictor of e-health adoption.

Chung (2015) investigated 'The Role of Culture in Adopting Smart Home Technologies', where he stated that there is a need to examine the role of cultural context in the acceptability of smart home technology. Chung discussed the technology acceptance model and the cultural factors, where he claimed that factors affecting the acceptance of such technology is far beyond the personal realm. Chuang stated that it is impossible to transfer the knowledge without considering the cultural differences between various users, which will affect the acceptability of the designed application by users from different cultural backgrounds. Chung claimed that there is a need to develop a more culturally-aware framework that can inform the design of cross-cultural e-Health applications to achieve a greater adoption of smart home technologies.

Jones (2007) evaluated an online university site and found that culture affected what metaphors and icons were acceptable to users. Words like ‘campus’ were found to be problematic, as the concept (and/or the word) is very American in origin (Evers et al. 1997; Jones, 2007). Other research has shown that users perform best on a fully translated and localised interface (Tractinsky, 2000; Zhu, 2015). Researchers have previously noted that cultural influence on design, technology use and acceptance goes beyond the need to translate an interface from one language to another. There are subtleties in the meaning that affect users’ reaction to and understanding of things like sounds, sorting order, images and icons, and calendars used, among other things (Russo and Boor, 1993). Translation has also been shown to be unhelpful in certain circumstances.

2.5. Patient-centred Approach for e-Health

2.5.1. Establishing the Need for A patient-centred Approach in the E-Health Domain

patient-centred evaluation studies in the e-Health information systems domain have tended to focus on IT adaptation and user satisfaction issues. Typically, studies on user satisfaction have investigated users’ opinions or attitudes on a rather general level, not in the context of usability research. Since the early 2000s, however, interest in usability issues has grown. This section describes an overview of usability-related studies in the e-Health information systems field based on literature available in the fields of e-Health information systems and human-computer interaction.

Why bother considering users in e-Health information systems development? Researchers working in the e-Health information systems field have suggested the following reasons:

- The starting point for development should be through insight into the healthcare work practices where the information systems are to be used (Nykänen and Karimaa, 2006).
- Only a system that reflects the professionals’ working practices will be accepted by them (Reuss et al., 2007a).
- Factors of usability and ergonomics are of key importance for the adoption of medical information system solutions in practice (Weber-Jahnke and Price, 2007).
- In order to avoid the currently faced dissatisfaction with and abandonment of this technology, significant attention should be paid to UCD guidelines during e-Health information systems development (Johnson and Taatgen, 2005).

- The design of successful user interfaces poses one of the most important challenges in the area of e-Health information systems (Patel and Kushniruk, 1998).
- Commitment to usability in medical product design and development offers enormous benefits, including greater user productivity, more comprehensive products, lower support costs, and more efficient development process (Gruchmann and Borgent, 2007).

Based on these comments, the need for user involvement seems to be clearly established. However, several researchers in the e-Health information systems field have highlighted the need for a more systematic approach to user perspectives throughout the development process. Among others, Park et al. (2006, p31) expressed their concern about and experiences with the current state of user considerations in healthcare technology development as follows: "*in healthcare the culture is still to train people to adapt to poorly designed technology, rather than to design technology to fit people's characteristics*". This claim has been supported by several researchers. De Rouck et al. (2008) argued that healthcare users still lag behind in participation in the development of technologies. Gruchmann and Borgert (2007) have suggested that the integration of a usability approach is not an easy nor a straightforward process, but requires the involvement of specialists trained in and experienced with accounting for the human factor. Chaudhry et al. (2006) have pointed out the need for additional studies in workflow redesign and human factors to fully realise the benefits of IT use. Among others, Gil-Rodríguez et al. (2007) argue that the study of organisational, contextual, and user variables affecting implementation of technological innovations is vital to guarantee that those innovations respond to existing problems in the healthcare system. Similarly, Paavola (2008) has concluded that success in IT projects often requires knowledge not only of the technology the applications, hardware and architecture but also of the users, the procedures, and the business.

2.5.2. The patient-centred Perspective

In 2002, Haux et al. (2002) suggested that three major goals would guide healthcare delivery development in the near future: patient-centred recording, use of medical data for cooperative care, and a framework for networked patient-centred healthcare. In the early 2000s, several visions of patient-centred healthcare were presented (e.g., Davis et al., 2004; Delbanco et al., 2001; Haux et al., 2002). These visions are characterised by the following aspects: a) information delivery and communication between clinicians and patients and other involved parties (e.g., family and social workers), b) coordination of care, and c) cooperative care. The visions also share the opinion that ICT has an important role in supporting the aspects of patient-centred care in practice. Davis and Venkatesh (2004) have not only shared their vision of patient-centred healthcare but also have provided ideas about how to get to a patient-centred practice. The suggestions related to information technology use and rethinking of healthcare models can be summarised as the following: 1) easy access implementation on supportive resources: the physicians must be given easy access to resources and tools they can implement easily in their practice; 2) the development of new tools that give patients access to their electronic medical records; 3) redesign of the care provided in the outpatient, hospital, and nursing-home settings; and 4) new models of team work.

Along with the idea of patient-centric practices, the development of e-Health information systems is heading towards more open access in relation to healthcare information and records. Tang et al. (2006) have described the fundamental intention of patient health record systems (PHRs), often referred to as personal record systems, as follows: patient health record systems (PHRs) are more than just static repositories for patient data; they combine data, knowledge, and software tools, which help patients to become active participants in their own care. When PHRs are integrated with electronic health record systems (EHRs), they provide greater benefits for customers than would stand-alone systems.

Compared to EHRs, PHRs are able to provide patients with novel access to their health information and an opportunity to add their own information. Technically, PHRs can take three approaches: 1) stand-alone (customer assumes responsibility for entry and maintenance of personal health information), 2) tethered (secure access to stored information), and 3) interconnected (customer can access and share data from multiple sources across organisations) (Tang et al., 2006). The core functionalities of PHRs include the ability to share test results and medication information, while the more specialised take account of functions like electronic appointment scheduling, e-visits, and interacting by email with the doctor (Dimick, 2008; Wiesenthal, 2009). Accordingly, many PHRs put the patients in control of who can access their records, allowing them to share their information with providers and caregivers.

PHRs are expected to improve healthcare by sharing patient information among authorised providers. For patients and citizens, PHRs provide great access to a wide array of credible health information, data, and knowledge. The possibility to leverage that access, together with the improved communication between healthcare professionals and patients, has the potential to improve citizens' health and manage their diseases. PHRs are also said to benefit healthcare professionals. If the patients could carry out part of the documentation themselves, this would reduce the workload of healthcare professionals (Häyrinen et al., 2008). In addition, the PHR-enabled communication can provide the healthcare professionals with more flexible working procedures and free resources to improve the efficiency of such personal contacts (Tang et al., 2006; Wiesenthal, 2009). However, many challenges to the deployment of PHRs seem to be similar to those for EHRs. Additionally, new potential groups of users, other citizens and their supportive parties usher in new challenges for healthcare IT development. According to Tang et al. (2006), several issues specific to PHRs are not yet well understood. These issues include citizen- or patient-related interface, technology, and access considerations relating to healthcare IT use. Tang et al. (2006) suggest that the developers and users of EHRs and PHRs should understand individuals and healthcare workers' mental models of the healthcare process and the related workflows. Furthermore, Tang et al., (2006) emphasise the need for developing an understanding of how the PHRs can fit into the flow of what individuals do on a day-to-day basis.

What is the current state of the patient-centred approach in healthcare? The fact that patients have a very limited access to their own health information can be considered as one salient implication of the failure of today's healthcare to provide patient-centred care and information. The widely adopted EHR systems are designed and targeted for healthcare organisations and hospitals' internal use. These currently used systems do not support interaction or collaborative actions between patients and healthcare workers. They do not allow the clinicians to link the patients into their own decision-making process or collect patients' self-reported impressions of how they are doing, nor do they support the clinicians to electronically interact with patients using smart interactivity and content.

In many rich countries the need for more open healthcare information delivery has been recognised and the idea of patient-centred healthcare is beginning to take root. Along with a number of ongoing projects in several countries, Finland and England developed an infrastructure for national healthcare information (Ruotsalainen et al., 2008; Health Committee, 2007). These projects have many elements in common, including the aim of involving patients in the use of their own health records. However, the question of benefits and evidence on increased quality of healthcare remains valid: what are the expected PHR benefits and how to get there?

2.5.3. The Clinician-Centred Perspective

According to Davis (1973), e-Health information systems are primarily about the timely delivery of relevant, needed information to the appropriate healthcare professional. This section gives an overview of healthcare technology development through a focused literature review, with an emphasis on clinical IT system development and clinicians' perspectives.

The history of e-Health information systems development begins about 50 years ago, as experiments with computerised medical recordkeeping began in the 1960s. At the same time, the concept of e-Health information systems seemed to find a permanent position amongst academic interest groups (Wilson et al., 2004). By the middle of the 1970s, computers were widely used in hospitals (Goldschmidt, 2005), as the benefits of using information technology to manage their complex and diverse work environment became evident. In the 1980s, healthcare organisations also introduced personal computers, and physicians began adopting electronic health record systems (Goldschmidt, 2005).

Since then, various healthcare-tailored applications for diverse practice settings and physician specialties have been developed to serve the needs of the profession. However, at the first appearance of these stand-alone applications it soon became clear that they poorly supported patient data exchange between hospital units and healthcare parties. The quest for integrated records that could follow the patient through the healthcare delivery system was announced.

In the late 1990s, EHR systems were identified as essential (Dick et al., 1997) and at the heart of the application of IT in healthcare (Grimson et al., 2000). Today, the range of EHR systems already in place is described as being huge (Wilson et al., 2004). In the literature, the concept of 'electronic health records' covers a wide range of different information systems, from files compiled in single departments to longitudinal collections of patient data (Häyrinen et al., 2008). Healthcare professionals use these records as their principal information repository for the purpose of setting objectives, planning patient care, documenting the delivery of care, and assessing the outcomes of care (e.g., Häyrinen et al, 2008).

In the 21st century, information technology in healthcare organisations has gained widespread usage. In recent decades, many European countries have adopted EHR systems with the aim of replacing existing paper-based patient records with EHR systems that enable better integration, sharing of information, and smoother collaboration amongst different healthcare providers. While national health record systems are still less common (World Health Organisation, 2008), various kinds of department-wide and organisation-wide systems have now been in use for many years. Additionally, nation-wide healthcare information infrastructure projects and strategies are under development in many countries (World Health Organisation, 2008). From the early 2000s, the ideology of patient-centred care has slowly entered the field and started to influence healthcare ICT development. The visions (e.g., by Davis et al., 2004; Delbanco et al., 2001; Haux et al., 2002) share the idea that technology has an important role in supporting patient-centred care, including in: a) information delivery and communication between clinicians and patients and other involved parties (e.g., family and social workers), b) coordination of care, and c) cooperative care. These changes suggest that healthcare technologies should evolve in the direction of providing a greater degree of open access to patient information and records.

As a consequence, the concept of a patient health record (PHR) system has been launched with the following understood meaning: PHR systems are more than just static repositories for patient data; they combine data, knowledge, and software tools, which help patients to become active participants in their own care. When PHR systems are integrated with EHR systems, they provide greater benefits than would stand-alone systems for customers (Tang et al., 2006).

The core functionalities of PHRs are said to include the ability to share test results and medication information, while the more specialised PHRs include functions like electronic appointment scheduling, e-visits, and interacting via e-mail with the doctor (Dimick, 2008; Wiesenthal, 2009). Furthermore, PHR-enabled communication can provide healthcare professionals with greater flexibility in working procedures and free up resources to improve the efficiency of personal communications between physicians and patients (Tang et al., 2006; Wiesenthal, 2009).

The concept that patients and citizens should take a more active role in their own care has been strongly encouraged and appreciated. e-Health and, more recently, m-Health (mobile health) are the terms behind these concepts, and describe the emerging ICT-supported practices and activities in healthcare. Most interested parties conceptualise e-Health as a broad range of healthcare technology applications that facilitate the management and delivery of healthcare. According to Mitchell (1999), e-Health describes the combined use of electronic communication and information technology in the healthcare sector for clinical, educational, and administrative purposes, both on-site (i.e., at the clinical or hospital) and remotely. From the viewpoint of healthcare workers, e-Health is thought to cover complex clinical applications that can support clinicians in diagnosis and treatment (Wilson et al., 2004).

Along with e-Health, the involvement of citizens in healthcare is now policy in many countries (Health Committee, 2007; Ruotsalainen et al., 2008). The future scenarios describing healthcare suggest that consumers will assume much greater financial oversight and responsibility for their healthcare, which in turn will drive the demand for valuable data that is readily accessible, reliable, and understandable (Leventhal and Barnes, 2015).

The development of e-Health information systems to date has concentrated on computer-based applications, without paying much attention to other areas of modern technology. However, interest in the adoption of wireless and mobile technologies inside hospitals has increased remarkably in recent years (Dolan, 2011). For example, a recent survey in the United States found that 64% of physicians have a smartphone, while 27% of primary-care providers and specialists say they have a tablet (Dolan, 2011). However, based on the results of this study, it remains unclear how widely these are used in clinical settings, since very few healthcare providers appear to have officially announced mobile healthcare pilots (Dolan, 2011).

2.6. Summary

The literature has shown that e-Health information systems are developed to deliver relevant information to the healthcare practitioner and support the various processes in the healthcare domain by enabling a seamless flow of information between different parties and different locations. Currently, there are a considerable number of e-Health information systems in use. The advancement in electronics has reshaped and influenced the delivery mechanism of health services. The way electronics and research in the e-Health information systems domain are evolving would suggest that the benefits are obvious in theory; however, the challenge remains in technology adoption. The issue is how both professionals and users/patients conceive such applications as useful and how they think those applications can enhance their day-to-day life, and how to address the negative impact of the lack of accommodating the patients as a key stake holder from the initial design stage.

HCI, and more specifically ‘user-centred’ research, has strongly emphasised the evaluation perspective in development. In general, the importance of, and the need for, a more comprehensive user-centred, culturally-aware design approach is becoming inevitable in order to increase the technology adoption rate.

UCD principles have proved to be an effective approach, and can be applied to a variety of usability testing techniques to evaluate the effectiveness of screen designs, functions, navigation paths, labels, and other elements of the interface with representative users. Data from iterative testing has informed modification and refinement of the application. Applying UCD and involving users throughout the entire process in the development of e-Health information systems intended for use by users/patients will ensure that their needs and expectations are met, and that the final e-Health information system is functional and acceptable

Involving the patients in the decision-making processes of tracking their health effectively can only be achieved if they have been involved from the research and design stage, not only after the product has been developed. Keeping our focus on the tasks and users throughout the development process helps to reduce the risk of designing an e-Health information system that is based entirely on what we consider important and useful rather than what the users/patients think would assist with self-monitoring activities. Furthermore, patients need to be involved in the ongoing evaluation of the developed e-Health information systems product so that we can obtain their feedback regarding the functionality, efficiency, ease of use and usefulness.

The Technology Acceptance Model (TAM) focuses entirely on theories derived from social psychology without due consideration of cultural factors that might influence user acceptance of a particular technology. This inhibits the use of the model across cultures and, as information technologies are dispersed beyond geographical boundaries, TAM faces the challenge of maintaining its global validity and reliability. The effect of the globalised IT market will definitely push TAM beyond its intended boundary, to address various cultural factors influencing systems’ acceptance. The solution will be a more generalised model, which is applicable and relevant across the IT systems domain and different cultural settings.

For the purpose of this research, the researcher feels that it is necessary to question TAM’s adequacy for research into the acceptance and usage of patient-centred e-Health information systems in the circumstances that exist in less-developed countries, such as those in the Arab world, in particular the UAE.

Although many attempts have been made to explain end-user acceptance behaviour, the models that have been developed still lack cultural sensitivity and user-centeredness. In the Arab world in particular, there seems to be a lower acceptance of e-Health information systems, which may be due to cultural differences and/or system design technological factors.

This study attempts to address this problem through the introduction of culture and technology design factors into the e-Health systems design domain by introducing a culturally-aware e-Health Technology acceptance model, ‘e-HTAM’, which will be the topic of the next chapter, where it is expected that the findings will help further assess and evaluate the impact of culture in the acceptance of e-Health information systems.

Chapter 3: e-Health Technology Acceptance Model

3.1. Introduction

Research into the technology acceptance model (Venkatesh and Davis, 2000) and the adoption of Internet-based healthcare applications has not been completely successful in establishing how they deal with factors related to technology and culture. Typically, technologies are designed within a cultural context that is often hugely influenced by the Western frame of doing, whereas users mostly use them within their own cultural frames. Today, users are variously located in different corners of the globe. As technologies travel to these new cultural contexts and engage new ways of doing often not anticipated during design, there arise significant technology transfer challenges (Sung and Gibson, 2015; Reinecke, 2011). While studies have focused on technology transfer into the developed countries with a presumption about technology-use fit, and a few have investigated how cultural values influence general acceptance and use of web-based services, details of how cultural and social values impact technology uptake and acceptance into other contexts remain understudied, particularly in relation to e-Health.

This study aims to explain the influence of technology design and culture on a patient's acceptance behaviour and to develop an e-Health acceptance model that incorporates technology design, cultural and social factors. Existing literature in technology acceptance theories, culture, human-computer interaction (HCI) and e-Health is reviewed. The aim is to contribute to the building of a model that can be used to enable the acceptance of a culturally sensitive e-Health service within an e-Health context. We describe the development of the model and offer designers ways of understanding use and design practice to enable better adoption of e-Health services. To better understand the relation between the variables that might affect users' intentions to use e-Health technology and to better inform the prototype design and implementation, a study was conducted in order to identify the variables that are considered to be significant to technology acceptance. The data gathered in the initial phase was analysed and used to devise the first e-HTAM. The result of the analysis was used as a set of design guidelines to the design and implementation of the prototype. The following section will elaborate on the process adopted to conduct the study.

3.2. Cultural Factors for e-Health Systems Design

e-Health is a discipline that concatenates computer/information science and healthcare. It deals with acquisition, optimisation, use, storage and retrieval of information in the health domain. e-Health information systems are progressing rapidly; however, their benefits cannot be considered to be universal because of the existence of disparities related to sociocultural, behavioural, environmental, or societal factors (Stojmenova et al., 2012). However, as they are perceived as the future solution to many healthcare challenges, they need to be researched and developed free from the current economic and political climate.

e-Health information systems can offer various advantages, such as allowing users/patients to assume responsibility for their own health. In addition, the fact that their online applications/services can be accessed 24/7 while being anonymous makes them more convenient for users. The Internet enables users/patients to communicate directly with healthcare professionals, and they can make use of social network forums. However, despite their advantages, there are some disadvantages and challenges that should be considered to ensure that measures can be taken to overcome them, such as the system's cultural awareness, patient-centeredness, service tangibility, service quality, and privacy and security.

The researcher found little literature relevant to a patient-centred, culturally-aware e-Health systems design approach. The literature that has been found (Valdez et al., 2012; Nazi et al., 2013; Iqbal et al., 2010) would suggest that e-Health system designers need to involve the targeted users of the products and/or applications throughout the entire design process; this can be achieved by conducting studies that focus on studying the influence of a patient-centred, culturally-aware e-Health system's design on technology acceptance/adoption. Insufficient patient cultural consideration in the design and product architecture of e-Health systems and the lack of evidence demonstrating their impact poses challenges for users adopting such applications.

The concept of personalising interfaces has become an integral part of modern software engineering, and, as the patient can be either local or global, the need to consider the patient's cultural preferences has become crucial to the marketability of e-products. This notion suggests that culture should be a focal part of any patient-centred application. Researches (Mohamed et al., 2011, 2012; Hofstede, 1984; Khushman et al., 2009) have confirmed that cultural orientation does influence users' preferences. For example, nationality, language, social structure, political norms, education, gender, and religion influence patient preferences in the Arab world.

The next section discusses the concept of culture, which is first discussed in a broad context by reviewing selected cultural models. This is then followed by a review of the concept of interface culturalisation, which accommodates both subjective and objective cultural variables into the interface design, and then assesses the applicability of the cultural model in the e-Health information system's usability design.

The section will also attempt to identify major cultural issues affecting system usability, in particular: (i) cognitive (localised and globalised interface elements, information architecture and patient interaction), (ii) affective (graphics and colours), perceptual (metaphors) and (iii) functional factors (Alharbi et al., 2015; Serge et al., 2015; Alqahtani el al., 2015).

Of the several cultural models referenced in HCI literature, those of Hofstede, Hall, Trompenaars and Hampden-Turner are outlined here. Subsequently, the application of these models is examined. Finally, the chapter considers what remains to be done in the field of patient-centred, culturally-aware e-Health system design, and how this research proposes to address those issues.

3.3. Models of Culture

Globalisation has transformed the world into a small village, which has in turn influenced individuals' behaviours; those individuals are a part of a community, and that community adheres to specific values, such as language, beliefs, norms, and rituals, which are collectively called culture (Wallace et al., 2013; Bandyopadhyay and Fraccastoro, 2007; Hofstede, 1984; Hofstede and Hofstede, 2005; Hofstede and Minkov, 2010; Nisbett et al., 2001; Trompenaars and Hampden-Turner, 1997).

The modern dynamic lifestyle has resulted in an interchange of people, ideas, and resources, ultimately affecting those on the move as much as those at home (Bruner, 2010). The results are cultural groups that maintain their identities across nations and different territories, which are referred to as 'sub-cultures', which are independent of spatial proximity (Gupta and Ferguson, 1997). Culture cannot be seen as a homogenous whole but is constantly changing.

This is also true when excluding the influence of migration. In many large countries, such as the UK and UAE, people refer to their national identity but at the same time practise various regional or local customs and values.

Cultural affiliation becomes a matter of context. In the context of a communicated cultural affiliation, it reveals that people generally think of culture as linked to geographical location, and thus relate it to a certain territory.

Anthropology views a person's culture as subject to change: people do not only acquire culture, they are also part of its creation. In the context of globalisation, change and exchange among different cultures are omnipresent. Analysing the way people handle these exchanges and possible alterations of cultural identity, anthropologists (Hofstede, 1984; Hofstede and Hofstede, 2005; Hofstede and Minkov, 2010; Hall, 1990; Trompenaars and Hampden-Turner, 1997) have found that globalisation does not transform different cultures into a homogeneous whole, and people do not necessarily absorb new cultural influences (Sahlins, 1999). Instead, they either develop a certain resistance to external influences, or adapt these influences to their own cultural context, which sometimes even enhances their own cultural identity (Sahlins, 1999).

From the above-mentioned, it can be concluded that culture is a collective phenomenon, consisting of unwritten rules of social interaction. It indicates what reactions are likely to occur in any given situation. Culture can influence an individual's behaviours, such as attitudes, learning style, living style, information processing and, of course, technology acceptance (Wallace et al., 2013; Bandyopadhyay and Fraccastoro, 2007).

This research considers national cultures as a context and a source of differences in how people relate to, work with and come to understand and accept technology. In this way, national culture is used as a context or frame of reference with which to understand the differences emerging between countries in the use and perception of e-Health information systems. For instance, Norman (1988) points out that those cultural conventions can often dictate how objects behave and how they are perceived. National culture is also the unit of analysis used by two of the cultural models described below. In many ways, culture affects our context of use and our perceptions. It infuses our everyday lives. For example, psychologists have found that culture influences judgement, memory, perception and the way we take decisions (Oishi et al., 1999; Nisbett, 2003).

Researchers have conducted various studies to better understand the effect of culture on technology acceptance in transforming and dynamic communities. For example, Hofstede (1984) and Trompenaars and Hampden-Turner (1997) have managed to systematically 'group' cultural values into measurable factors that can be used to study the effect of culture in various domains.

In HCI domain, cultural models are currently being employed to design a more user centred desgins (Lin et al., 2016; Kyriakoullis and Zaphiris, 2015; Marcus, 2015; Rau, 2013). Hofstede's cultural dimensions (1984) are, by far, the most cited model in the HCI research domain. Other models are gaining ground nowadays, such as Hall, Nisbett et al. and Trompenaars and Hampden-Turner Those models present a variety of ways to understand and employ culture. However, it is the discretion of this research researcher to employ Hofstede's dimension, because of its relevancy, applicability, and because it is the most cited cultural model in the HCI research domain (Wallace et al., 2013; Mohamed et al., 2011, 2012; Bandyopadhyay and Fraccastoro, 2007; Nisbett et al., 2001).

3.3.1. Hall's Cultural Theory

Hall (1990) focused on establishing culture's elemental units, which, according to him, will allow the researchers to contrast and compare 'cultural elements'. Researchers are engaging in a continuous process to identify and analyse common measures of culture. It was Hall's viewpoint that there is a need for methods that enable researchers to abstract cultural values that can help form the building blocks of culture, which will facilitate the comparison of one culture with another.

Hall's quest for this method and these building blocks was driven out of the need to create a methodology as well as a set of data that is 'teachable' (especially to non-specialists) and replicable. Hall's needs arose from trying to teach culture to people outside the field of anthropology, such as Foreign Service employees and those working abroad.

For Hall, culture is a set of learned and shared behaviours as well as a way in which a people communicate with, understand, and relate to each other and to the world. Culture controls the way that people organise life, think and behave, and influences their underlying understanding of family, government, society and even humankind.

Hall 1990s quest for a theory of culture led to identification of what are called the Primary Message Systems. These systems make up human activity; they are non-lingual forms of communication and are biologically based. To understand a particular culture one must understand how it relates to these systems. Hall identified 10 primary message systems, where each one refers to a different aspect of human activity and how it structures culture; they are Interaction, Association, Subsistence, Bisexuality, Territoriality, Temporality, Learning, Playfulness, Defence and Exploitation.

Interestingly, it is not these non-linguistic systems of human activity for which Hall is most often cited in HCI literature. Rather, it is his definition of the concept of high-low context cultures, which refers to how information (a message) is stored and how it flows.

In high-context cultures, the information contained in a message is mostly implicit; most of the information is internalised in the physical context or in the person her/himself. The messages in a high-context culture are simple with deep meaning. By contrast, in a low-context culture the message has more of an explicit nature; the meaning is given in the code of the message and little is encapsulated or ‘internalised’. For example, cultures such as the UK and USA are considered as low-context cultures, whereas Arab cultures such as the UAE and Kingdom of Saudi Arabia (KSA) are high-context. Communication in the UK and USA tends to be very specific; things need to be spelled out. In the UAE, communication is based more on what one already knows about an individual, and the emphasis is on remaining polite and retaining control rather than on spelling out what one wants and needs. Low-context cultures tend to be rooted in the past and slow to change, valuing tradition, while high-context cultures tend to be faster-paced and more amenable to change, and less concerned with the past and tradition (Hall, 1989). Both high and low contexts have been employed in the HCI domain to explain design variation and to suggest reasons for differences in communication and design patterns.

3.3.2. Trompenaars and Hampden-Turner’s Cultural Dimensions

Similar to Hall, Trompenaars and Hampden-Turner (1997) defined seven dimensions of culture that can be used for comparison purposes. Their model approached cultural differences with the intention of improving people/businesses communication and collaboration in a common way. They perceived culture as a system of shared meaning, shared beliefs and a shared meaningful context. They further argued that it is also a way in which a group of people solves problems and reconciles dilemmas.

Trompenaars and Hampden-Turner (1997) categorised culture into three levels:

1. Explicit culture (observable reality: food, language, architecture, art, etc.).
2. Norms and values (shared sense: what is good, bad, right and wrong).
3. Assumptions about existence (survival and problem solving).

These levels or what are also called ‘layers’ influence all actions and behaviours, yet all but the explicit layer are hidden from awareness. Trompenaars and Hampden-Turner (1997) empirically assessed their seven fundamental dimensions by which cultures vary. The first five dimensions identify how people relate to others, the sixth dimension identifies the relationship to time and the final dimension identifies the attitude to the environment. According to them, the seven dimensions are:

1. Universalism/ Particularism: universalism is a view of ‘the right way to do things’, which will always apply. Particularism, on the other hand, holds that circumstances and relationships will influence what needs to be done and how.
2. Internal/External attitude towards nature: cultures also vary on how they perceive the outside world. Motivations and influence come either from inside the individual or from the outside environment. Is nature to be controlled and imposed upon or is it to be valued and synchronised with?
3. Individualism/Communitarianism: is about ‘me’ or ‘us’?
4. Neutral/Emotional: the neutral approach to relationships is detached and about reaching an objective. The emotional approach is more focused on human relationships, and emotional expression is not inappropriate.
5. Specific/Diffuse: specific relationships are defined and limited by contracts and strictly agreed business relationships, whilst diffuse relationships are defined by personal contact and getting to know the people involved in the relationship.
6. Sequential/Synchronic relation to time: cultures vary with regard to whether they value the now and the future or the historic and the past. Cultures also vary in their sense of time as linear or as circular.

7. Achievement/Ascription: achievement-based cultures are those in which status is built on accomplishments and experience. Ascription-based cultures are those in which status is assigned and based on one’s connections.

Some commonalities with the elements in Hall’s primary message system are evident. For example, Hall’s ‘exploitation’ seems to relate closely to internal-external attitudes to nature and his ‘temporality’ relates closely to sequential synchronic relations to time.

Trompenaars and Hampden-Turner’s dimensions have been employed in the HCI domain to discuss patterns of design across cultures. However, the model is limited by its dependency on management and business, which brings into question its applicability in other fields.

Trompenaars and Hampden-Turner (1997) dimensions shares several commonalities with Hofstede’s (1984) cultural dimensions, as will be discussed in the next section.

3.3.3. Hofstede’s Cultural Dimensions

Hofstede (1984) defines culture as a collective programming of the mind that makes one group unique from another. Patterns of thinking, feeling and potential activity all go into this programming. Culture is learned throughout life. First, it is taught by parents in the form of examples and corrections, then by teachers and interactions with peers. The young in any one culture will vary in their ‘programming’ from the old in the same culture, and indeed differences between cultures will manifest themselves beyond age differences and similarities.

As mentioned above, ritual, heroes, symbols, and values are all core elements of culture; it is, however, Hofstede’s discretion to focus on values as a core element of culture. Hofstede developed the Value Survey Module instrument in an attempt to measure and classify culture.

Hofstede argued that cultures became static in nature; however, nowadays cultures are far more advanced, flexible, and transferable than their old versions. Hofstede claimed that cultures at the national level (social class, generation, gender, ethnicity, religion, etc.) are easy to study. Although Hofstede admitted that nations are considered as one homogenous group, they are the result of what he called the collective programming of the people who live in them.

Hofstede empirically validated his cultural dimensions through data collected from 180,000 IBM employees. IBM represented the perfect choice as it is considered to be a multinational organisation. Hofstede stated that five dimensions are all related to subjective culture. He classified the cultural dimensions into high and low power in the score line he devised. Hofstede implemented a score line that range from 1 as lowest to 100 as highest score (50 as a midlevel), he used the score to compare cultures.

Although the scores may vary, the relative position of one culture as compared to another is very stable. Those dimensions are:

- **Power distance**: refers to share of power, where, in a high power distance culture individuals expect to be led and not treated equally. People in a low power distance culture strive for equality and seek justification for inequalities in power sharing.
- **Uncertainty avoidance**: refers to ability to cope with uncertainty and risk. A high uncertainty culture indicates a low level of tolerance for uncertainty. People have differing levels of anxiety when dealing with uncertainty, as opposed to the more universal feeling of fear caused by known or understood threats. Hofstede (1984) argued that cultures vary in their avoidance of uncertainty with different values regarding formality, punctuality, legal-religious-social requirements, and tolerance for ambiguity. According to Nakata and Sivakumar (1996), customers of a high uncertainty avoidance culture would hesitate to choose uncertain situations, while customers of low uncertainty avoidance ones are more accepting of uncertainty and risk.

  Donthu and Yoo (1998) found that high uncertainty avoidance customers expected higher service quality compared with customers with low uncertainty avoidance. In addition, Furrer et al. (2000) found that uncertainty avoidance is positively correlated with reliability, responsiveness, assurance, and empathy, and is negatively correlated with website design and visual appeal.
- **Masculinity vs. femininity**: refers to gender roles rather than the physical characteristics, and is associated with assertiveness or tenderness in the patient. Masculine cultures value assertiveness, ambition, success, and performance. In such cultures, big and fast is beautiful, and clear gender roles are the norm. On the other hand, 'feminine' cultures tend to value beauty, nature and nurture, and blurred gender roles. According to Hofstede people who score fifty or less in this dimension as considered to be Masculine in nature.

- **Individualism vs. collectivism**: refers to the role of the individual and the group. In collectivism, culture loyalty is paramount, and over-rides most other societal rules. Hofstede found that the extent to which individuals take care only of themselves or are loyal to a group and society varies according to levels of individualism or collectivism. Individualistic cultures value personal time, freedom, challenge, and such extrinsic motivators as material rewards at work. Individualism concerns the relationship between individuals and other individuals or society; thus, one is expected to look after one's self or immediate family but no one else. According to Hofstede people who score fifty or less in this dimension as considered to be collectivist in nature.

The cultural dimensions primarily focus on identifying the thinking, reaction and feeling patterns that form the cultural mental model (Eringa et al., 2015). This suggests that the cultural dimensions to some extent influence our cognitive ability to perform tasks, which in turn influences our problem-solving and reasoning approach.

Users' perception of unambiguous and simple data can be influenced by their cultural orientation; for example, users who are from low uncertainty avoidance tend to prefer summarised information, as opposed to those from high uncertainty, where detailed information is favoured. High uncertainty avoidance users tend to be more emotional and worried about their superiors' satisfaction, which puts them under pressure and causes unnecessary anxiety (Marcus, 2002).

Masculine classified cultures are known to be impatient and quickly want to complete tasks; this in turn indicates the level of quality they are expecting and also producing.

People from collectivist and high power distance cultures will feel uncomfortable in expressing opinions that will confront their superiors, unlike those from low power distance and individualist cultures, who are likely to express their opinions even if they contradict those of their superiors.

Limitations and Justification of Hofstede's Dimensions

Despite its popularity, Hofstede's cultural dimensions theory has been criticised by many researchers. Interestingly enough, Hofstede (Hofstede and Minkov, 2010) himself admitted that his research instrument was developed from a Western perspective; he justified it by stating that it was developed to try to find out if they were like us.

Baskerville (2003) suggested that the Hofstede study lacks insight into the richness and depth of culture, as it is based on the IBM sample, which does not represent the global communities and therefore affects the overall credibility of the theory. This was further supported by McSweeney (2002) where he argued that Hofstede's homogeneity perception of culture is a problem in itself.

Baskerville (2003) further questioned Hofstede's approach by analysing the link between nation and culture, as this is one of the main pillars of Hofstede's theory; this again was supported by McSweeney (2002), where he additionally stated that the Hofstede findings were further negatively affected by the use of the central tendency measure.

McSweeney (2002) suggested that Hofstede could have categorised the data based on demographics such as education, religion, gender, language, age, etc., to find differences in the sample. McSweeney further argued that central tendencies tend to ignore the large divergence in individual answers within a culture and ignore the deeper, richer meaning of social factors; nonetheless, the use of IBM as a sample to study culture was arbitrary, and was mainly used to obtain richer results.

In terms of the theory's questionnaire, Eringa et al. (2015) was very critical and questioned its validity, arguing that it had been developed from a Western prospective and claiming that it did not fit into the original international variables.

In the Information Systems (IS) domain, the model was criticised as well, as, according to Walsham (2002), Hofstede's model sees culture as a static phenomenon, while the nature of culture is reflexive and changeable. Walsham also claimed that Hofstede's cultural dimensions are not easily transformed into effect on work patterns.

Hofstede cultural dimensions are employed in a wide range of disciplines ranging from information technology, economics, health, business, social sciences, etc. (Khanum et al., 2011, 2009), which might be due to the theory’s simplicity and its naming of five constructs that can be used to study cultural influence.

In particular, Jones (2007) argued that, while Hofstede’s work is not without its critics, it remains one of the most widely used pieces of research among scholars and practitioners and that their overview illustrates the importance of culture, and the impact that each of Hofstede’s dimensions has on information system design and development.

The researcher position, is that, the cultural dimensions managed to clarify the cultural themes and grouped them into factors that could be used to validate the implication of culture in many fields by comparing them to Hofstede score ‘index’. However, the score was based on a data that was collected in 1980th, since then culture and the way information and knowledge are transferred changed significantly, thus, the cultural dimension’s score that is generated in 1980th and remained static since then, does not reflect the current state of the culture. This research will propose a way of addressing the static nature of Hofstede scoring mechanism, and make the score reflexive in nature to represent the current state of the individuals.

Based on the aforementioned discussion, this study considered Hofstede’s cultural dimensions as relevant and suitable and fit for its purposes because: (i) it is the most cited cultural theory, (ii) it does not overlap with other cultural theories, (iii) it is analytically flexible, (iv) it has been successfully used to show cross-cultural differences in Internet technology diffusion and adoption; and (v) it is valid for analysing regional and international differences.

The following section of this study proposes a new Technology Acceptance Model for e-Health (e-HTAM) specifically developed as a means to support this study. The aim of the e-HTAM is to investigate how the impact of integrating cultural factors to TAM (Davis, 1989; Davis et al., 2004) and how that applies to the acceptance and use of e-Health web-based services.

3.4. Methodology

The main objective of this study is to investigate both the influence and effectiveness of a patient-centred, culturally-aware design approach on e-Health web-based services’ acceptance. In order to meet this objective, a mixture of research techniques have been used. These methods include a pilot study, an online survey, and later in chapter five, a patient based evaluation.

In this methodology section an overview of the design of the research is presented. This includes consideration of the research methodology, design and sampling method used.

3.4.1. Background

Quantitative research is concerned with explaining the relationships between variables and testing specific hypotheses. There are two main ways of achieving this goal; either by the use of experiments or by the use of surveys with closed ended questions.

In the quantitative research process, a researcher develops theories and hypotheses from the available literature about the relationship or effect between two or more variables. A researcher then chooses a way of testing these hypotheses (if they can be tested), that eliminates as many confounding factors or influences as possible. It is also important at this stage that the method chosen allows for the rejection or acceptance of the alternative hypothesis. Thus, choosing a sample large enough that can be tested via techniques with sufficient statistical power is essential. Furthermore, choosing the appropriate techniques and sample sizes to test the hypotheses ensures that the methodology is efficient both in time and cost.

Surveys are a common method of gathering quantitative data, however, the widespread use of this methodology does not imply it is the best methodology available. In reality, the most important consideration in choosing a survey over any other methodology is the cost (Easterby-Smith, 1991).

Often, though, there are few quantitative research options realistically available. For example, it would usually be too costly and impractical to carry out an experiment on hundreds of people for a single study. Notably, even if the cost of a moderate sized experiment of 50 people was equal to the cost of a survey of say 1,000 people, the smaller experimental sample size would make it statistically more difficult to decisively reject or accept an alternative hypothesis[2].

Despite these distinct advantages, especially in terms of cost, there are some drawbacks to the adoption of a survey as a primary method of data collection. The most common issue is that the survey design is not designed adequately to answer the hypotheses. This is obviously more

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[2] Statistical calculations for calculating the probability of hypothesis tests are based on the sample size. Where a sample is larger, then the results will tend towards significance compared to an identical test (in terms of means and variances) where the sample is smaller. This is because sampling more people implies a greater level of confidence with the results.

likely using a bespoke survey that has not been used before. A standardised survey (or set of questions that have been used previously) does not tend to suffer from this problem. However, even a standardised survey can present complications when applied to samples from different cultures or when translated into different languages.

While qualitative data collection formed a large part of this study, the primary of mode of data collection used was quantitative during the survey stage. The rationale for focussing on this methodology for this study was:

- There had not been a previous empirical study relating to role of culture in the e-Health domain design examining the relationships between cultural factors and e-Health acceptance.
- This research is conducted in over two geographic locations (UAE and UK) patients making it cost prohibitive to set up identical experimental collection methods in two different locations thousands of miles apart.
- This study includes a range of cultural and social behavioural factors that cannot easily be tested simultaneously or at a reasonable cost using any other methodology.
- The ability to collect a large sample of data at a reasonable cost outlay ensures that the statistical analysis of the data collected will produce statistical tests capable of rejecting or accepting the alternative hypotheses.

3.4.2. Sample Design

Choosing a representative sample of the population will typically, be the best and most practical method available (Sekaran, 2003). In statistical terms, a sample of the population can yield an acceptable overall level of accuracy compared to sampling the whole population. Therefore, selecting a representative sample of the population is efficient in terms of cost and time resources compared to sampling the population as a whole (Yoon, 2002).

There are two main criteria that need to be considered in sample design: These are the representativeness of the sample and the objectives of the study (Sekaran, 2003). Although many sophisticated methods are available for sampling populations via various types of probability sampling techniques, some of these methods may only needed in situations where very large samples are sought and the method of data collection is costly e.g. face-to-face interviews.

In such instances, costs associated with an interviewer travelling between locations (and the time spent travelling) have a serious limitation on the practicality of selecting a sample completely at random geographically; especially if the desired sample is a whole region or country. In such situations, the use of cluster and strata sampling are typical (Hair et al., 2003). This is because this method allows for clusters of respondents (as opposed to one respondent) to be selected at single locations so that the travel costs are significantly reduced. However, this comes at the statistical cost of increased sampling errors compared to a fully random sample of the population (Levy and Lemeshow, 1999).

In comparison, using data collection methods where no physical contact is required between a researcher and a respondent, the scope for using various sampling methods is less limited. Telephone and postal surveys have inherent staffing and/or postal costs. However, online surveys are comparatively cheap to administer. Therefore, unless there are specific cost implications for choosing a particular sampling method, a simpler sampling approach is often more accurate and cost effective. Moreover, there are often costs associated with sampling with a complicated method. This is in the expertise and software required to design and analyse the results.

A methodology for gathering a random sample from the population would typically involve choosing a sample using either random number tables or, as is more common, by using random number generation in computer software. However, by drawing a sample completely at random, there is a possibility that the sample may not be representative of the population it has drawn from. This is simply because a random sample could well be biased by chance.

For this reason, most probability sampling techniques attempt to minimise this effect (Sekaran, 2003). Thus, constraints on the sample can be made where each element of the research population is known but the characteristics are not necessarily equal. Given that the representative nature of the sample is critical for any generalisation of the results (Saunders et al. 2000; Tabachnick and Fidell, 2001; Hair et al. 2003), it is clearly important that any possible sampling biases are considered and minimised.

Despite this consideration, the most common probability sampling technique is to draw a simple sample at random from the population (Burns and Bush 1998). Furthermore, the most frequently used sampling techniques in research are those that are not probability based.

According to Samouel et. al., (2003), the most common of these non-probability sampling methods used are convenience sampling or quota sampling.

In convenience sampling, the sample includes those subjects that are the easiest to reach to participate in the study. This method, by its very nature, is likely to include some sampling biases. This is because those easiest to sample are not necessarily the most representative.

In quota sampling, the sample frame is set so that a number of people with certain characteristics are sampled until the frame is populated (Cooper and Schindler, 2001). However, there are certain limitations to this method. The most obvious of these is that the researcher needs to know (or guess) the characteristics of the person before they are sampled. This is obviously more effective in situations where a researcher is on a street canvassing people. However, even then there can be obvious issues with attempting to guess some characteristics from the way someone looks. Furthermore, there can be inherent time issues involved if people without the desired quota features are not present at a particular location at a time of day.

The main disadvantages of samples that are not based on probability sampling techniques are that sampling error cannot be calculated and results cannot always be generalised. Despite these drawbacks, there can be advantages. The most obvious of these advantages is that these methods are less costly than probability sampling (Yoon, 2002). They can also be executed more quickly and the resulting samples are often reliable enough to be reasonably representative (Hair, et. al, 2003).

In this study, simple random sampling was chosen for reasons of simplicity and ease of application. Despite the limitations of this method, it is free of classification error and it allowed the data collection to be efficiently conducted. In addition, there were constraints on the information available about the populations to be sampled and constraints on the availability of participants across two geographically distant countries. As such, the advantage of the method chosen is that the technique did not require any additional information on the population (such as geographic areas).

3.4.3. Sample Size

There is no consensus regarding what is the exact or right number for a sample. One obvious limitation is the cost of a larger sample versus a smaller sample. In general, larger sample sizes are always preferable but the increase in accuracy has to be weighed against the cost (Yoon, 2002).

However, there are some basic statistical considerations in quantitative analysis such as the Central Limit Theorem. This dictates that a sample of 30 is considered large enough to be approximately normally distributed (Saunders et al., 2003). However, other minimum sample size constraints exist if subsamples (groups) are to be compared within the data by methods such as t-test or one-way ANOVA. With a one-way ANOVA, a figure of ten observations per group is sometimes used (Norman and Streiner, 2008). For more complex analyses such as multiple regression analysis, a minimum of 100 observations is cited (Hair et al., 2003).

Other statistical rules of thumb have also been proposed. Comrey and Lee (1992) and Tabachnick and Fidell (2001) have suggested at least 300 cases for a sample to be comfortable while a sample of 500 or more regarded as ‘very good’. Other heuristics, based on statistical considerations of degrees of freedom in statistical tests and models, are that the sample size needs to be either seven-to-ten times the greatest number of items in any variable or seven-to-ten times the greatest number of antecedents to a construct (Chin, 1998).

In some disciplines, calculating the Statistical Power before collecting a sample is common. This is used to estimate the minimum requirement of the sample size depending on the statistical analysis that will be used based on the pre-determined statistical power required. One of the drawbacks of this method is that it requires certain characteristics of the sample to be estimated beforehand such as the standard deviation. Therefore, this method is typically more useful in determining the required sample size where previous studies allow a reliable estimate of these measurements.

The following sections will discuss the pilot study and the survey conducted to collect and analyse the data to inform the future direction of this research.

3.4.4. The Study Questionnaire

According to Saunders at el (2003), there are many types of questionnaire design depending on how it is administered and the amount of contact with respondents. These designs can be divided into self-administered questionnaires and interviewer- administered questionnaires.

There are various methods of delivering Self-administered questionnaires. Traditionally, these were usually posted to respondents who returned their completed questionnaires by post after completion (postal or mail questionnaire). In some studies, they could be delivered by hand to each respondent and collected later (a personally administered questionnaire).

The emergence of the internet expanded the methods of delivery available. They can now be delivered and returned via email, or via online questionnaires. Notably, one of the major advantages of these methods is that there is no additional time and expense for data entry onto a computer system compared to paper methods. There is, however, some additional time that needs to be spent creating and testing the online survey.

Compared to other data collection methods, the use of questionnaires has its own advantages and limitations. The main advantages of the questionnaire are that it is a versatile method for collecting data from a population and that it is relatively low-cost (for both researchers and participants). Furthermore, questionnaires allow a large amount of data to be captured at once.

Nevertheless, questionnaires have many disadvantages. Notably, they require expertise in their design, conduct and interpretation. This can be especially true when using and analysing the results of questionnaires based on Likert Scales. These scales arguably require some expertise to design and analyse correctly (Carifio and Perla, 2007).

3.4.5. Objectives of the Questionnaire

There have been no previous studies that have investigated the role of cultural factors in influencing the acceptance and use of the e-Health web-based services. Therefore, the aims of this research were to get a better understanding of individuals’ beliefs and attitudes towards such emerging technologies.

Furthermore, the study sought to establish cultural factors that underlie cross-cultural differences (or similarities) between The UK and The UAE in the acceptance and usage of e-Health web-based systems.

The application of a questionnaire methodology in this setting was thought to be the best way of collecting data for this purpose. This was in part due to the issues discussed earlier in this chapter relating to cost and effectiveness. Moreover, the methodology has been previously used successfully by researchers in related studies within Arab countries (Straub et al., 2001; Akour, et al 2006).

3.4.6. Questionnaire Development

A structured questionnaire was developed to answer the research aims. This was designed to be personally-administered for the pilot study. The rationale behind using this method was to increase response rate and increase the questionnaire reliability and validity (Sounder, et al 2003). This methodology also has the benefit that the researcher is available to answer any questions or comments regarding to the survey. Moreover, in The UAE culture, there is a general preference for personal contact rather than alternative communication methods such as emails or letters. Therefore, it was likely that this methodology was a more appropriate method for collection data within an Arab society.

Based on the outcomes of the pilot study, as online survey was chosen as the method to deliver the rest of this study questionnaires. This was due to the advantages of low cost, faster response rate, lack of data entry and convenience. This methodology also has the advantage of a higher response rate (typically 70%) that is better than other methods such as online or postal surveys (Babbie, 1998).

3.4.7. Questionnaire Content

The questionnaire used to collect the opinions of the respondents is shown in the Appendix C. The following is a summary of the items assessed and details of the corresponding statements to which the responses were sought:

- I prefer e-Health websites that are easy to navigate
- I prefer e-Health websites that are fun and enjoyable to use

- I prefer to use e-Health websites that provide detailed information about the disease which I inquire about, rather than general information
- I prefer the use of multimedia (voice, image, video) to learn about disease or other health issues than visiting the clinic
- Accessing medical or health services via the Internet helps me save time and effort
- I prefer to use e-Health websites that enable me to control the way the information is displayed and be able to personalise it to suit me
- I intend to use the Internet to book my medical appointment, if such service is available
- I intend to use the Internet to obtain health information
- I prefer to visit well known and trusted e-Health websites
- I prefer to visit an e-Health website that I have previously visited
- I prefer e-Health websites that are societal and focus on mutual relationships
- I prefer to use non-emotional e-Health websites
- I prefer e-Health websites that enable me to communicate with others to discuss my health concerns
- I prefer to read the minimum information about the disease I enquire about
- I prefer to use e-Health websites that have complex interface functionalities
- I prefer to use e-Health websites that that allow me to personalise the interface
- I prefer to use e-Health websites that communicate with me
- I prefer to use e-Health websites that serve my requests in a timely fashion/manner
- Feel and look (intuitiveness) of the website interface is important to me
- The Internet is safe I do not fear someone might misuse my personal information
- The contents of the e-health website I visited is relevant and credible
- People who influence my behaviours think that I should use online health services.

The questionnaire consists of questions related to the respondent’s background and possible factors that may influence their acceptance and usage of e-Health websites. Questionnaire design was divided as:

- Classification data: Obtaining general background information related to the participants, including location, gender and educational background.
- Cultural variables: Respondents were asked questions relating to culture. These cultural variables were hypothesised to affect user acceptance and usage of e-Health web-based

services. Measurements included subjective norms, trust, power distance (PD), uncertainty avoidance (UA), masculinity/femininity (MAS)

- TAM Variables: These questions were based on variables from previous studies with relevance to the concepts Perceived Usefulness, Perceived Ease of Use and Intention to Use.

In the questionnaire design, five point Likert scales were used ranging from ‘strongly agree’ to ‘strongly disagree’. An additional response category ‘I have not used it’ with value ‘6’ was added to the scale during the pilot phase, as it was expected that not everyone respondents would have used or experienced e-Health web based services (this was removed in later versions of the survey).

The reason for adopting this methodology is that Likert scales are a generally accepted method of data collection used in survey and, as such, are known to have a good level of reliability and validity (Burns, 2000). Thus, they provide a simplified method of attitude measurement (Burns, 2000).

The use of Likert scales has particular statistical advantages. For example, it allows the researcher to answer research questions using standard statistical techniques to test hypotheses (Carifio and Perla, 2007). Furthermore, confirmatory factor analysis can be used with this methodology in order to validate the questionnaire design (Moser and Kalton, 1983).

There are also behavioural design reasons that make the adoption of Likert scales attractive. Adopting these scales for data collection allows respondents to make simple judgements that do not confuse the respondents with excessive choice. Despite this simplicity, they also allow the respondent a degree of choice to reflect the intensity of their views.

3.5. The Pilot Study

A pilot study “helps researchers to refine their data collection plans with respect to both the content of the data and the procedures to be followed” (Yin, 1994). It is used to cover all of the research questions and objectives to reveal any potential problems in the delivery or design. This ensures that the questions used are unambiguous, that the length of the questionnaire is reasonable, that the layout is clear and that the instructions accompanying the questionnaire are easy to follow.

Therefore, the pilot stage increases the questionnaire's reliability and content validity by reducing errors in interpretation. It is also useful in determining adequate sample sizes by allowing the variability in responses to be estimated (Gilbert 2001). Consequently, when the survey is analysed, the validity and reliability of the statistical results are improved (De Vaus, 1991, Churchill, 1999).

3.5.1. The Pilot Study Method

The pilot survey was distributed to 70 potential respondents. Thirty-five people were asked to participate in UK of whom twenty-six responded (74.3% response rate). Thirty-five people were asked to participate in the UAE with twenty-four respondents (a 68.6% response rate). 50 questionnaires were returned representing a response rate of 71.4%. This response rate was very high and indicated that using a self-administered questionnaire was the correct distribution method to ensure a high response rate.

One of the pilot study objectives was to estimate the time needed to complete the questionnaire to ensure it did not take excessively long to fill out. The results of the pilot indicated that the time needed to complete the questionnaire was around 20-30 minutes. This suggested that the questionnaire was not necessarily clear and easy to complete. Feedback from respondents further verified this observation.

Moreover, one oversight was that the questionnaire was provided in English to the respondents at both locations. It was initially expected that participants would be able to use the English version of the questionnaire This proved to be a serious problem for some participants from The UAE where Arabic is the primary language. The researcher along with other colleagues provided verbal translation to the participants during the session where the data was captured. Translation quality was provided by a range of people and therefore may have negatively affected the reliability of the questionnaire. This finding prompted the need to translate the questions into Arabic language before the final distribution of the questionnaire to The UAE participants. Copies of the English and Arabic versions of the questionnaires available in appendix C.

Another finding was that the 'I have not used it' that was added to the scale was not used by any respondent. Feedback was given that this element was rather confusing so it was removed from the final questionnaire.

The labs in The UAE where the pilot data was collected was connected via Wi-Fi to the internet through a proxy services, which control the internet access. The proxy setting in the labs was very sensitive and blocked mass access to the online questionnaire, which in turn imposed unnecessary stress on some participants.

One item that was not included at this stage was 'Tangibility'. Professionals that took part in the pilot suggested that this item should be included as it may have an effect on e-Health acceptance.

3.5.2. Data Collected from the Pilot Study

Descriptive statistics of the data gathered from the pilot is displayed in the table (1) below. Notably, the standard deviations in this table show that, generally, the variation in respondents was not very large.

Table 1: Descriptive Statistics

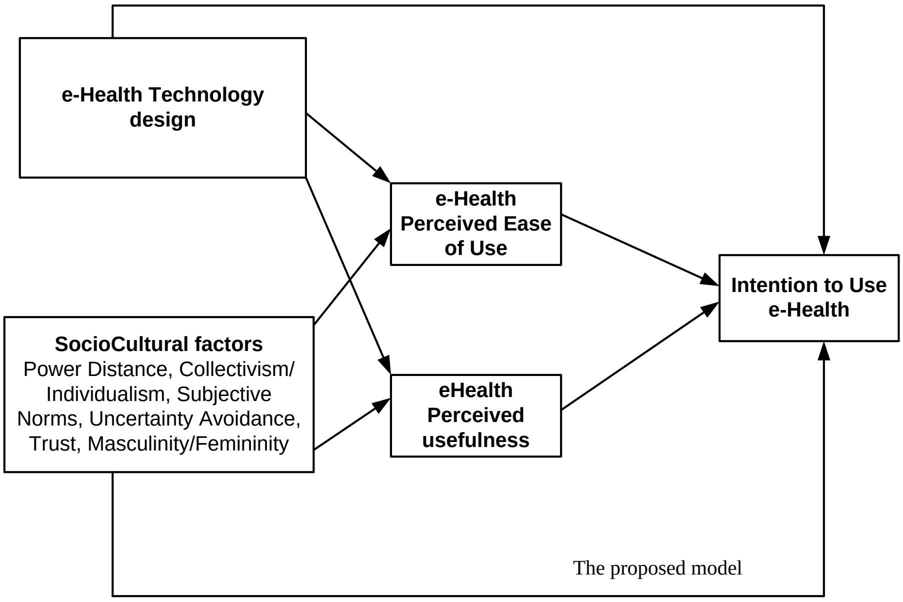
(n=50)	Mean	Std. Deviation
[PD] I should seek my parent permission to use the internet	2.12	1.34
[UA] I would prefer to be diagnosed online	2.86	1.37
[MAS] My gender affects my freedom of using the internet	1.76	1.16
[Trust] The internet based health services can help better care to patients	3.90	1.22
[SN] People who are important to me think that I should use internet based health information	3.04	1.05
[PU] The internet based health information is useful for my family	4.26	1.19
[PEOU] I can search the internet for health information or services	4.56	0.79
[I2U] I would use the internet to book my medical appointment	4.18	1.56

Generally, comments and feedback given during and after the pilot study proved to be very useful. The pilot study provided a preliminary indication of the influence of Arab culture in using e-Health websites. This information, alongside a systematic revision of related literature, ultimately resulted in an improved study design that was enhanced both by prevailing theories and an updated set of empirical observations. Amendments were made and, in general, the draft questionnaire had an acceptable level of content or face validity. For this reason, it was decided that no further pilot was required.

The next sections will discuss the main survey that was conducted to develop a culturally sensitive e-Health technology acceptance model to better understand the significance of the culture and its role in e-Health web-based acceptance.

3.6. A Proposed Model for Electronic Health Technology Acceptance

Several theories related to technology acceptance were discussed in Chapter 3. Davis' Technology Acceptance Model (TAM) emerged as the most suitable model as it builds on the previous models, such as Theory of Reasoned Action (Fishbein and Ajzen, 1975), and incorporates factors that were not included in previous models, such as subjective norms, voluntariness and image (Davis et al., 2000). Previous studies (Gefen and Straub 1997; Akour et al., 2006) have suggested that TAM has a slightly better predictive power than related models. TAM is a widely accepted model in information systems literature, and offers a practical and robust basis for understanding technology adoption. However, it lacks the integration of a wider cultural factors' influence and technology design factors, such as those in Hofstede's (1984) and Trompenaars and Hampden-Turner's (1997) studies.



The proposed model

Figure 7: e-HTAM proposed model

The proposed mode of e-HTAM (Figure 7) proposition is that intention to use (I2U) or acceptance of e-Health services is formed by the patient's perceptions of e-Health technology design adequacy and relevancy, especially its navigation-ability, quality, validity, ease of use and usefulness of information. TAM constructs namely 'perceived usefulness' (PU) and 'perceived ease of use' (PEOU), along with other sociocultural constructs such as Power Distance (PD), Trust, Subjective Norm (SN), Tangibility (Tang), Uncertainty Avoidance (UA), and Masculinity (MAS) were all taken into consideration.

e-HTAM's initial proposition is that there is a direct correlation between:

- Perceived ease of use of e-Health services and perceived usefulness of e-Health acceptance.
- Perceived ease of use of e-Health services and intention to use e-Health services.
- Perceived usefulness of e-Health services and intention to use e-Health services.

The questionnaire was subjected to rigorous revision following the feedback from the pilot phase. In line with the findings of the pilot, the final sets of approved questions were translated into Arabic to be used by participants from The UAE.

Questback.com was used to publish the survey online in both English and Arabic. The links were sent to randomly selected participants' email addresses. The recipients were asked to self-administer the survey from their home. This was to overcome the proxy issue faced in The UAE in the pilot stage phase of this study.

One hundred and fifty UK respondents were asked to participate. There were one hundred and sixteen respondents to the UK survey representing a response rate of 77.3%. One hundred and fifty UAE respondents were asked to participate. There were one hundred and thirteen respondent giving a response rate of 75.3%. Overall, there were a total of 229 responses from 300 contacts resulting in a response rate of 76.3%.

3.7. Statistical methods adopted for this study

Statistical methods were used to assess the relationship between the independent variables (e-Health technology design, Cultural Variables, Perceived Usefulness and Perceived Ease of Use) and the dependent variable (Intension to Use e-Health web-based services).

Descriptive analysis was employed to establish the general characteristics and to summarise information about the main variables of this study. This involved the calculation and presentation of sample means and standard deviations of observed scores. Simple component analysis was used to interpret the findings.

Correlation coefficient measures the relationship between variables, showing the direction of correlation and its strength. It only indicates the existence of relationships between the variables, not the causality of the variables (Schumacker and Lomax 2004). In this study, Pearson product-moment correlation coefficient analysis (*r*) was employed to perform the preliminary correlation analysis. *r* ranges from -1.0 to +1.0. The closer *r* is to +1 or -1, the more closely the two variables are related, however, an *r* value that is closer to 0 indicate that there is no relationship between the variables. A positive *r* value suggests that if a variable increase the other variable increases as well, unlike the negative *r*, where if one variable increased the other decreases (inverse correlation).

A significant (p value) difference in the results indicates that the mean average agreement to a statement was greater in one group than the other group. In statistical analysis, significance level of $p < .05$ indicates a significant difference between the groups. In terms of hypothesis testing, where the significance level is $p < .05$, this indicates that there is a difference between the groups and that the alternative hypothesis can be accepted. Where no significant difference is detected, the result would indicate that the alternative hypothesis is rejected i.e. there is no difference between the means.

3.8. Results' Discussion and Analysis

3.8.1. Perceived Ease of Use of e-Health (PEOU)

PEOU is measured through two statements (Figure 8) aimed at investigating the effect of ease of use on intention to use e-Health services. The results indicate that users are in favour of sites that allow them to easily find information they are seeking, as when they have been asked [PEOU 1: I prefer e-Health websites that are easy to navigate], the mean (M) value was 3.99

and standard deviation (SD) was .91.

This was supported by the other statement where the participants indicated that they are willing to revisit sites that are easy to navigate [PEOU 2: I prefer e-Health websites that are fun and enjoyable to use] where the M was 4.02 and SD was 1.06.

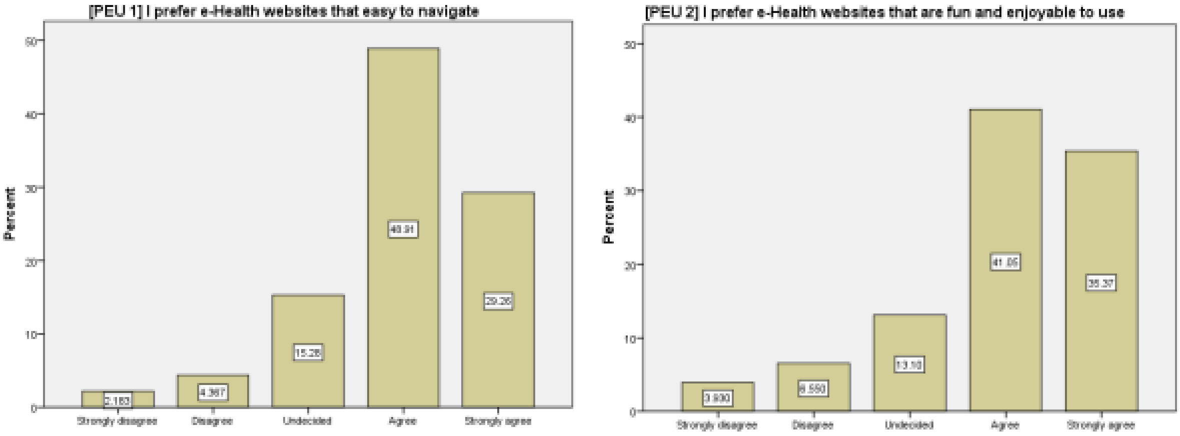


Figure 8: Perceived Ease of Use of e-Health data distribution

Perceived ease of use suggests that e-Health website is perceived as easy to use, as the majority (78%) strongly agreed that they prefer websites that are designed in a way that makes the information easy to access and understand compared to 6.6% who think that ease of use would not motivate them to use e-Health services. Ease of use also seems to have significant correlation with e-Health websites that are considered enjoyable and fun to use, as 76% of participants agreed with the statement.

Davis (1989) defined perceived ease of use as the extent to which one believes that using a system is free from effort. The results above suggest that perceived ease of use has considerable influence on behavioural intention to use e-Health websites as long as they are free from effort and anxiety. As a result, it can be associated with uncertainty avoidance in Hofstede's (1984) cultural dimensions. To reduce uncertainty and increase the perceived ease of use, the developer needs to consider how to develop interfaces that support users during their interaction.

3.8.2. Perceived Usefulness of e-Health (PU)

PEOU is measured through two statements (Figure 9) aimed at investigating the effect of perceived usefulness of e-Health websites on intention to use e-Health services. The survey indicates that e-Health is perceived to be useful with an average score of ‘agree’; the individual item M score is between 3.43 and 4.21 with an average M of 3.8.

The results indicate that users will be inclined to visit websites that provide relevant and authentic health information, which suggests that there is a correlation between retention and the quality of information provided [PU: I prefer to use e-Health websites that provide detailed information about the disease which I inquire about, rather than general information], where M was equal to 4.21 and SD was .778.

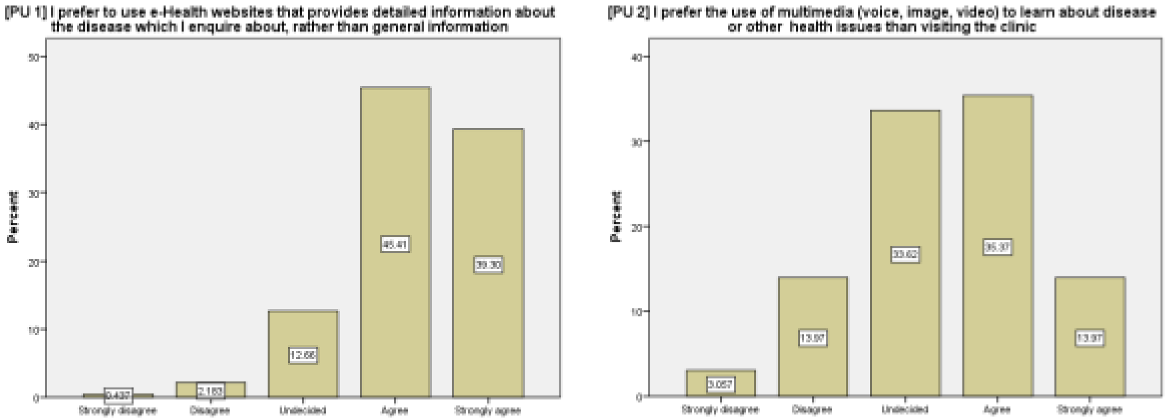


Figure 9: Perceived Usefulness [PU1 and PU 2] of e-Health data distribution

The users seem to be flexible and able to compensate for the tangibility of services by alternative means such as video, audio, and images, which suggests that a face-to-face health service is not a concern if the nature of the enquiry is to access information [PU 2: I prefer the use of multimedia (voice, image, video) to learn about disease or other health issues than visiting the clinic], where M was =3.43 and SD was .996. They also perceived that websites that provide health information saved them time and effort [PU 3: Accessing medical or health services via the Internet helps me save time and effort], where M was 3.72 and SD was .96.

The users seem to prefer health websites that are interactive, as these websites allowed them to control the interface personalisation [PU 4: I prefer to use e-Health websites that enable me to control the way the information is displayed and be able to personalise it to suit me], where M was 3.79 and SD was .880 (Figure 10).

This suggests that users want to have their identities represented/matched in/by the interface; personalisation to some extent allows them to do that. These results suggest that e-Health website acceptance largely depends on the content design and interface functionalities.

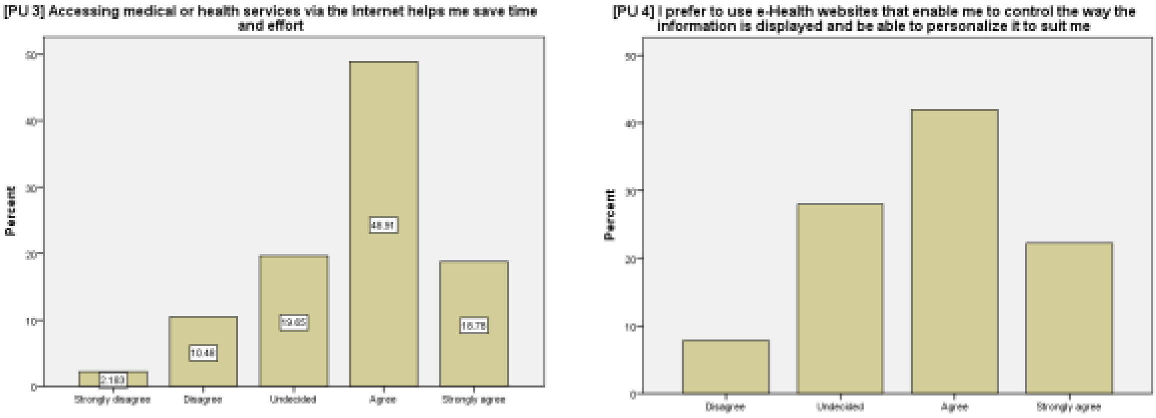


Figure 10: Perceived Usefulness [PU3 and PU4] of e-Health data distribution

3.8.3. Intention to Use e-Health (I2U)

Intention to use is defined as the person's desire and willingness to commit to a specific task or activity (Davis, 1989). This variable was measured through two statements aimed at investigating the intention to use e-Health 'web-based' services and information. The results (Figure 11) suggest that participants have a positive attitude towards e-Health services, as they were positive in relation to [I2U 1: I intend to use the Internet to book my medical appointment, if such service is available], where M was 3.74 and SD was 1.17. As indicated, 67.68% have a positive intention towards the e-Health 'web-based' services, compared to 17.47% who are not keen to use the services.

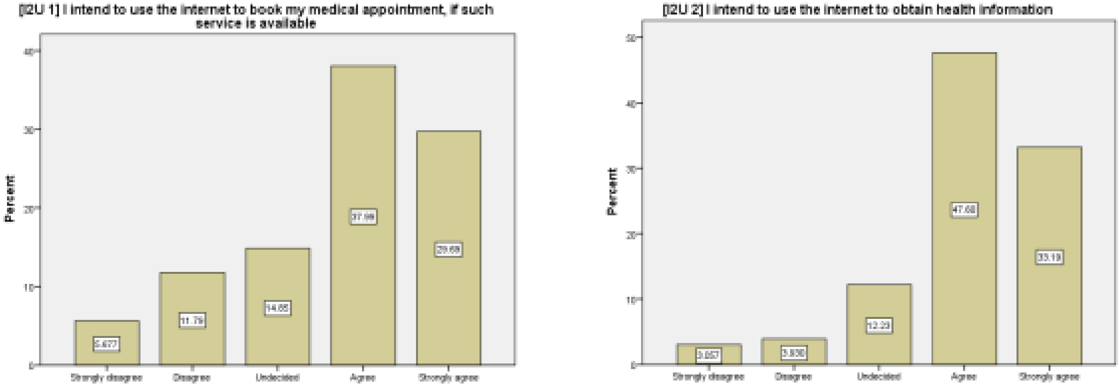


Figure 11: Intention to use e-Health services data distribution

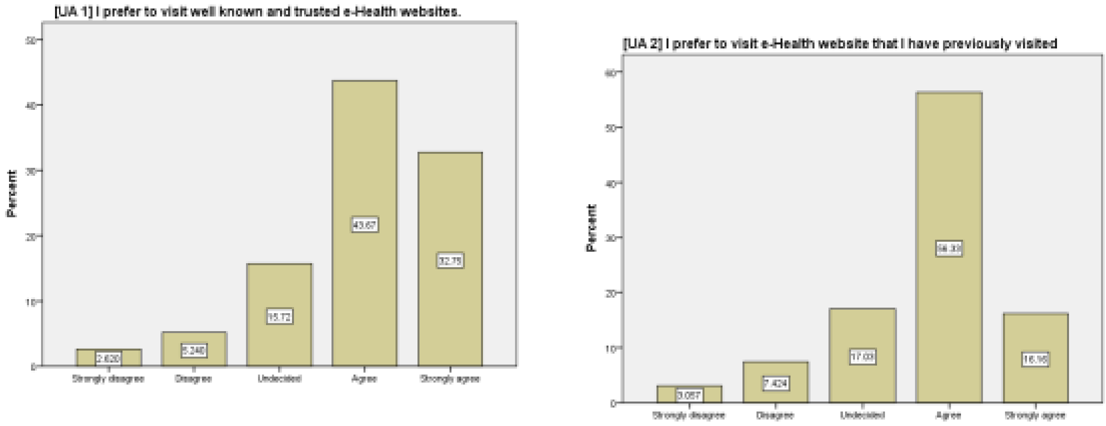
The positive intention outcome is also supported by participants' feedback when they were asked [I2U 2: I intend to use the Internet to obtain health information], as the M was 4.04 and SD was .943. As indicated, 67.68% have a positive intention towards the e-Health 'web-based' services, compared to 17.47% who are not keen to use the services.

The results indicate that intention to use e-Health services is positively influenced by the ease of use and the perceived usefulness of the services. The results are in line with previous studies of technology acceptance (Davis et al., 1989; Venkatesh and Davis, 2000). Based on this, it can be argued that users' acceptance of e-Health services could be predicted by their intentions, which could be determined by the perceived ease of use and perceived usefulness variables.

3.8.4. Uncertainty Avoidance (UA)

Uncertainty Avoidance refers to the degree a person might feel threatened or worried by carrying out a specific action (Hofstede, 1984). The results (Figure 12) suggest that participants have a negative attitude towards unknown or new e-Health websites, as [UA 1: I prefer to visit well known and trusted e-Health websites] generated an M of 3.99 and SD of .97, where 78% stated they prefer well known and trusted e-Health websites, compared to 7.9% who are more likely to be risk takers and could deal with uncertainties more comfortably. This was further supported by their preference for using e-Health websites that they had visited before [UA 2: I prefer to visit an e-Health website that I have previously visited], where M was 3.75 and SD was .920. As indicated, 72.49% are in the high uncertainty classification, as they prefer to visit e-Health websites that they have visited before, compared to 10.48% who again are more likely to tolerate risk.

Unpredictable situations can limit users' behavioural intention, 'tolerance', to use new services; the UA could be mapped to the Trust factor, as the majority of the participants preferred to use trusted e-Health websites, which suggests that new e-Health services will be perceived as a 'risk' for users, which indicates that high UA will negatively influence the acceptance of new e-Health services. This suggests that UA is associated with e-Health website assurance, content quality, navigation-ability, responsiveness and language of the e-Health website interface design.


[UA 1] I prefer to visit well known and trusted e-Health websites.

[UA 2] I prefer to visit e-Health website that I have previously visited

Figure 12: Uncertainty Avoidance data distribution

3.8.5. Masculinity/Femininity

This dimension refers to the gender role, where masculine culture tends to be more assertive and competitive, while feminine culture tends to be more emotional and caring (Hofstede, 1984). The results (Figure 13) suggest that participants are more from a feminine culture, as [MAS1: I prefer e-Health websites that are societal and focus on mutual relationships] generated an M of 3.20 and SD of 1.07, with 41.4% indicating that participants prefer e-Health websites that are colourful and more friendly, focused on people and the role of technology to support social communication, and do not differentiate between gender in their interface design, ‘blurring the role of gender’, compared to 24.01% who are more of a masculine culture, which suggests that participants prefer e-Health websites that are technically focused, and equipped with functionalities that help them to perform the tasks quicker.

This is further supported by [MAS2: I prefer to use non-emotional e-Health websites], where the M was 2.51 and the SD was 1.029. About 54.15% of the participants indicated that they do prefer emotional e-Health websites, compared to 14.5% who prefer to use assertive e-Health websites that focus on performance.

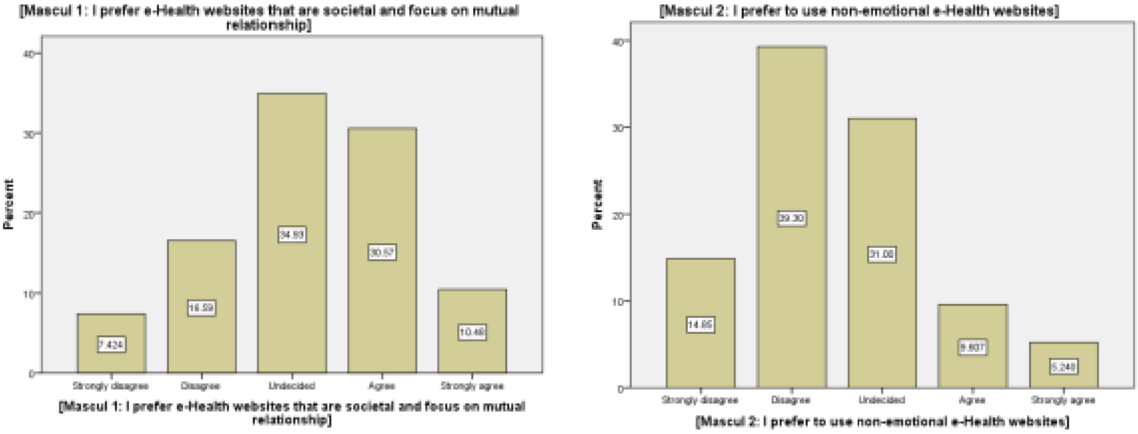


Figure 13: Masculinity/Femininity data distribution

3.8.6. Collectivism/Individualism (IND)

The IND dimension refers to the degree to which people are integrated into groups (Hofstede, 1984). The results (M= 3.91, SD=.884), as shown in Figure 14, suggest that participants are more collectivist in nature when it comes to their health. As shown in Figure 14 that a 72.92% of participants prefer to share and learn from others’ health experiences, and do not feel threatened by exposing their health-related issues to the wider e-Health community [I prefer e-Health websites that enable me to communicate with others to discuss my health concerns], as they perceive that the benefits of learning from others’ health experiences are of great value, compared to 7% who are more individualism oriented, and do not prefer to discuss or share their health issues with others.

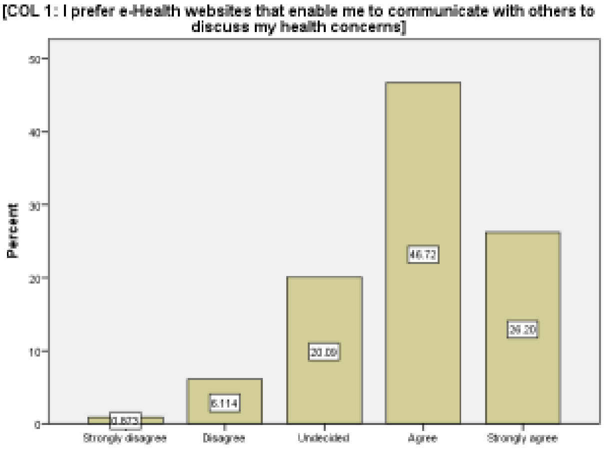


Figure 14: Collectivism/Individualism data distribution

3.8.7. Power Distance (PD)

PD represented navigation choices and density of information. As shown in Figure 15, 54.58% indicated that they would like to read as much as available about their related symptoms, compared to 26.2% who indicated that they are only interested in the minimum information

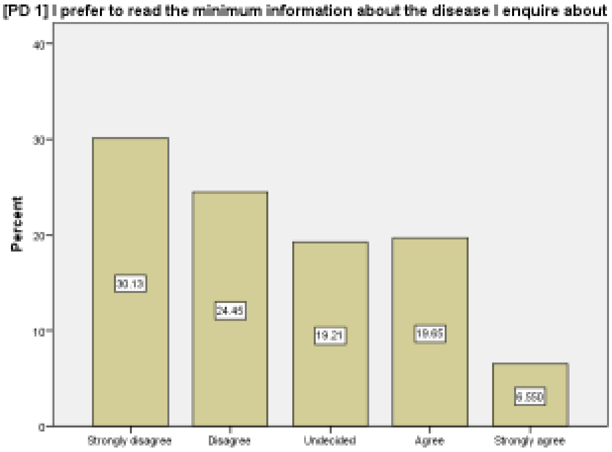


Figure 15: Power distance data distribution

Results (M = 2.48, SD=1.3) indicate that the majority (56%) disagree with the statement [PD 1: I prefer to read the minimum information about the disease I enquire about]; they do not believe that someone should limit their access to health information. This indicates that e-Health services should be able to cater for both categories of users in order for the service to be more appealing and acceptable.

3.8.8. e-Health Technology Design (TechDes)

The Technology Design factors (TechDes) influence was measured through the capability of the interface to be interactive, personalisable, complex, and provide accurate information. The interface complex functions requirement was measured through [TechDes 1: I prefer to use e-Health websites that have complex interface functionalities], where (M=3.10 and SD= 1.04 (Figure 16). Results indicate that 35% of the participants were of a neutral opinion, whereas 28% prefer an uncomplicated interface, compared to 37% who prefer to have a complex interface. These diverse opinions suggest that interface design should be carefully taken into consideration, as designing the interface functionalities without taking users into consideration will negatively affect adoption rate.

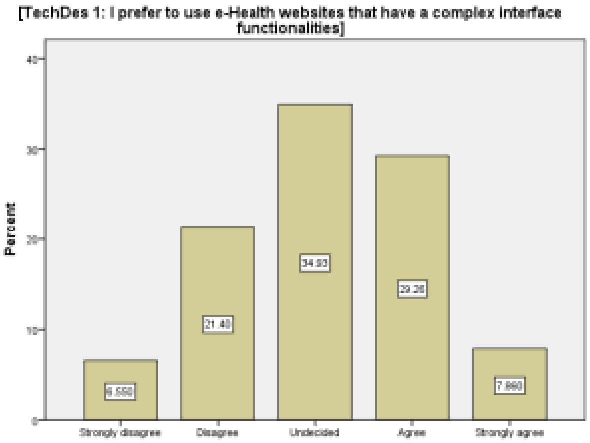


Figure 16: Technology design [TechDes 1] data distribution

Interface personalisation as a requirement was measured through [TechDes 2: I prefer to use e-Health websites that that allow me to personalise the interface], where the M=3.80 and SD=.946 (Figure 17). About 68.12% of the participant indicated that they do prefer e-Health websites that allow them to personalise the interface to better suit them, compared to 9.61% who believe personalisation is not an issue for them. In both cases, the interface is important; the principle of one size fits all does not help the adoption of e-Health websites. It is therefore recommended to equip the interface with advanced functionalities that allow the users to control the interface feel and look, including hiding any un-wanted functionalities and contents (Reinecke, 2011).

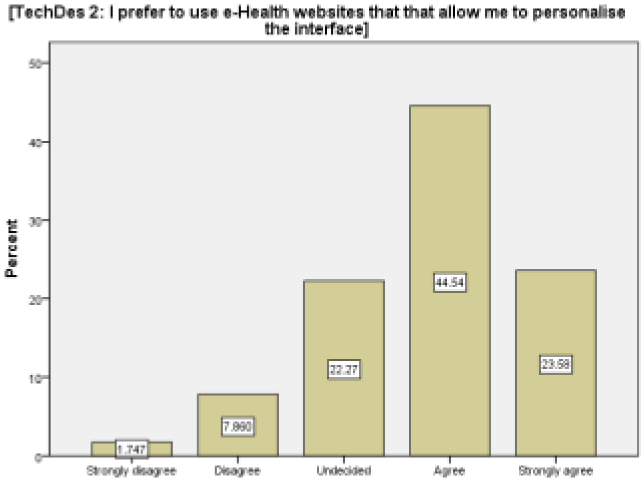


Figure 17: Technology design [TechDes 2] data distribution

Interaction as a requirement was measured through [TechDes 3: I prefer to use e-Health websites that communicate with me]. The mean was 3.36 and SD was 1.1 (Figure 18). As indicated, 52.4% of the participants were in favour of an interactive interface, compared to 25.32% who indicated that interactivity is not one of their preferences. Interactivity delivers the right information to the right person at the right time, compared to static interfaces where the information is the same for everyone. Participants indicated that they were inclined to use websites that serve their individual needs in real-time interaction, and those that provide more meaningful information than static interfaces.

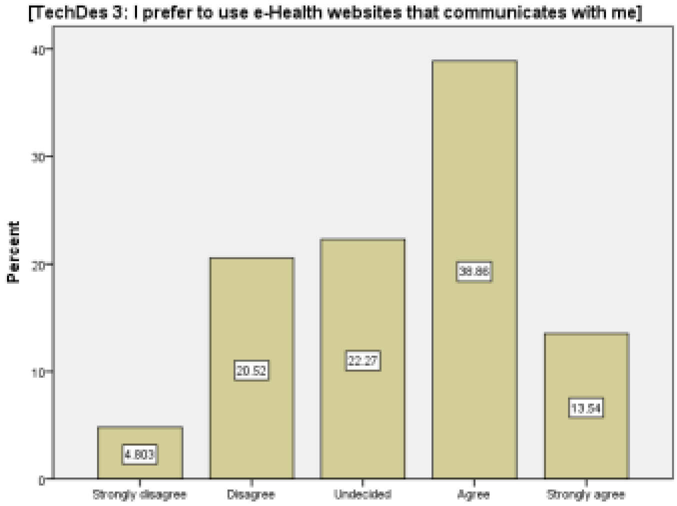


Figure 18: Technology design [TechDes 3] data distribution

System responsiveness as a requirement was measured through [TechDes 4: I prefer to use e-Health websites that serve my requests in a timely fashion/manner]. Mean was 3.93 and SD was .843 (Figure 19). About 79.48% of the participants indicated that they prefer a system that responds to their query without delay, compared to 6.55% who indicated that response rate is not an issue for them. The results indicate that responsiveness of e-Health websites should be perceived as an integral part of overall website or service robustness criteria. Systems should be designed with that principle in mind, as poor design or logic techniques can negatively impact the acceptability of the service provided by e-Health websites.

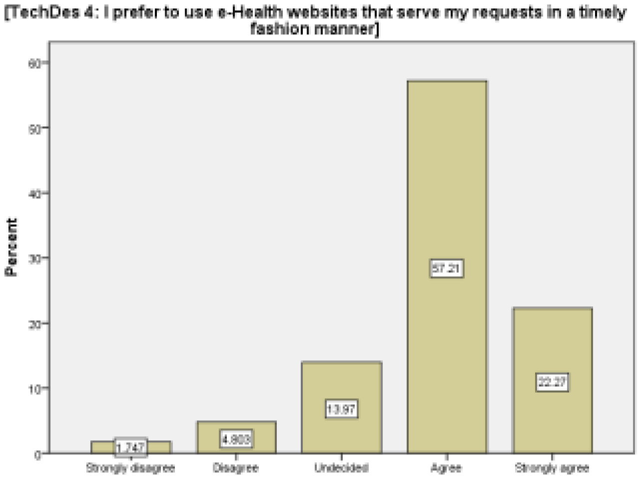


Figure 19: Technology design [TechDes 4] data distribution

Interface intuitiveness as a requirement was measured through [TechDes 5: Feel and look (intuitiveness) of the website interface is important to me], with mean = 4.14 and SD = .931 (Figure 20). About 82.96% of the participants indicated that the feel and look of the interface was important to them, compared to 7.42% who indicated that the intuitiveness of the interface was not a concern for them. Typically, a patient’s first impressions about a system interface in part drives her/his initial intentions to use the system. The results indicated that designing an interface that can cater for the appropriate feel and look is very likely to influence the users’ behavioural intention to accept e-Health services.

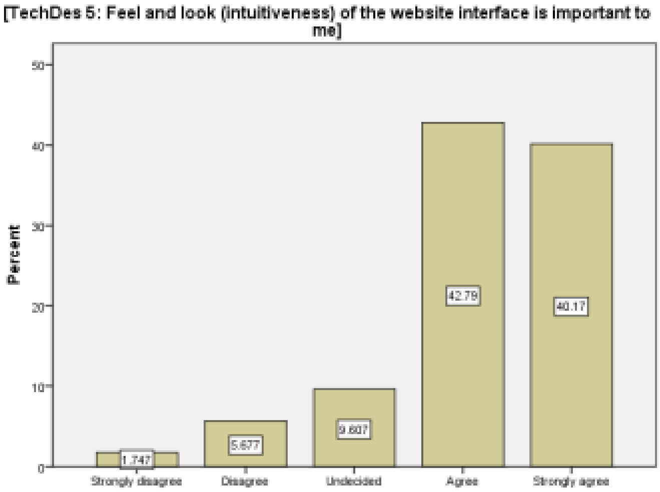


Figure 20: Technology design [TechDes 5] data distribution

3.8.9. Trust

Trust investigates the respondents' trust in using the Internet as a service channel (Gefen et al., 2003). The majority of the respondents were undecided (M=2.85, SD=1.1). When they were asked to rate the statement "The Internet is safe and I do not fear someone might misuse my personal/financial information": 33.2% of the population sample were hesitant to trust Internet safety, while 28.4% are willing to provide their personal and financial information online. About 38.4% of the participants do not believe that the Internet is safe and do fear that their financial and personal data will be misused, as illustrated in Figure 21. The majority of the respondents were neutral (M= 2.97, SD=1.11) when asked to rate the statement "The contents of the website are relevant and credible": 34.5% of the population sample hesitated to trust Internet health information, whereas 34.1% did not trust Internet health information, compared to 34.4% who believe Internet health information is credible and can be trusted, and hence perceived it as useful.

These statistics indicate common issues for web surfers; there is a need for e-Health service designers to take necessary measures to deal with the 'threat' of trust; personal or confidential information should only be requested if it is crucial to the task that the patient wants to perform online; and the contents that are displayed to the users should be relevant to each patient's query. e-Health 'web-based' services are intangible. Providing images, animations and clips of professionals in the field may help address tangibility and credibility issues, which could impact positively on e-Health acceptance.

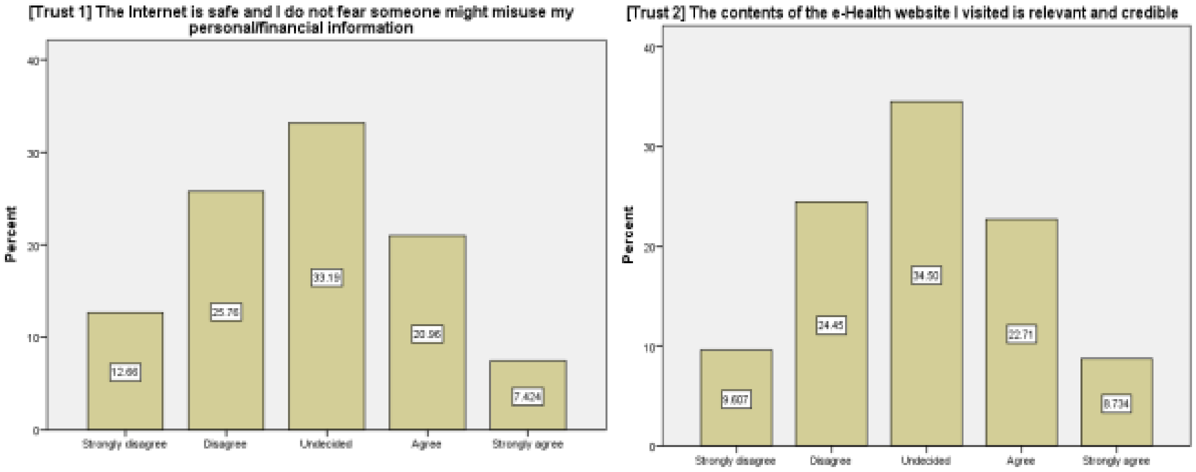


Figure 21: Trust data distribution

3.8.10. Subjective Norms (SN)

SN refers to the influence of others on one's behavioural intention. Venkatesh and Davis (2000) argued that SNs significantly influence a person's behaviour if the behaviour in question is of a mandatory nature. The majority of the respondents were neutral (M= 3.12, SD=1.1) when they were asked "People who influence my behaviour think I should use online health services". Results show that 31.9% (Figure 22) of the population were undecided, while 28.8% did not agree that others influence their behavioural intentions to use online health services, compared to a majority of 39.8% who agree.

An implication of the result is that subjective norms have a reasonable influence in societies where people live as groups, or what are called collectivist cultures, as people in such cultures perceive higher social pressure to follow their seniors or people who are important to them. This suggests that one way of promoting e-Health services is through places where people live, work or study together, as friends, colleagues or family members are expected to have a high degree of social influence on one another's use of the technology.

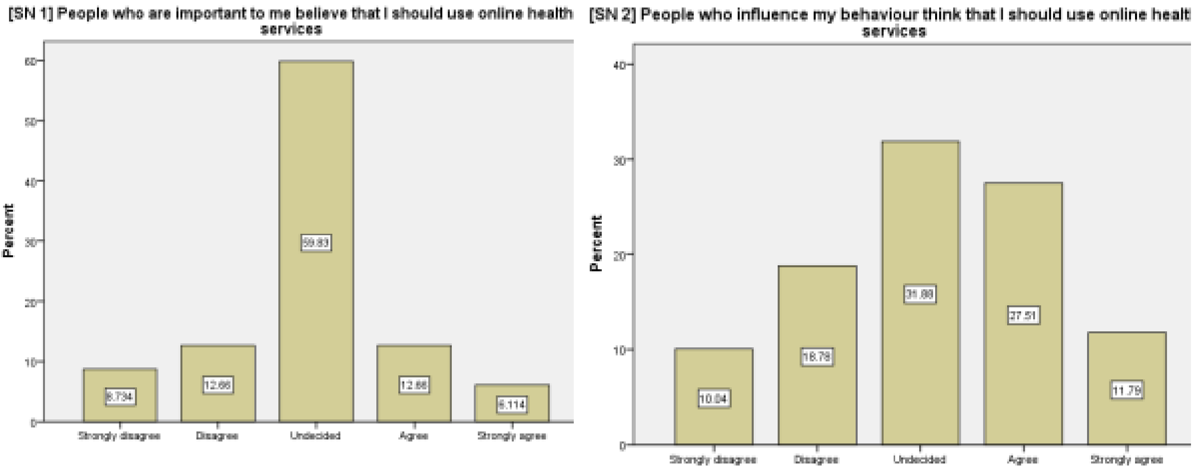


Figure 22: Subjective Norms data distribution

3.8.11. Analysis of e-HTAM Factors

Pearson Product-Moment correlation coefficient analysis was used, as it measures the relationship between variables and shows the direction of correlation and their strength. The correlation only indicates the existence of relationships between the variables, not the causality of the variables (Pallant, 2010). Table 2 shows the correlation between variables tested, while Figure 23 illustrates the direct and indirect correlation between the variables.

Perceived usefulness was found to be significantly correlated to I2U e-Health services ($r = .519$, $p < 0.0001$). The correlation suggests that the users believe that using e-Health websites should be hassle-free, and the interface should impose very little cognitive stress on them. The correlation also suggests that perceived usefulness affects participants' behavioural actions, especially their intention to use e-Health services; hence, perceived usefulness should be a key design requirement as it is a key driver of the acceptance of e-Health services. In order for e-Health services to be perceived as useful, they need to appeal to the users. Users normally look for cues to reduce cognitive load. The use of images, videos, and interface personalisation-ability along with cultural consideration will positively increase the adoption rate of e-Health services.

Table 2: The model correlation table

Pearson correlation (2-tailed)		
Perceived ease of use	Intention to use e-Health	.406$^{**\ (000)}$
Perceived usefulness		.519$^{**\ (000)}$
Technology Design		.392$^{**\ (000)}$
Uncertainty Avoidance		.385$^{**(\ 000)}$
Collectivism/Individualism		.195$^{**\ (.003)}$
Power Distance		-.188$^{**\ (.004)}$
Masculinity		.142$^{(.078)}$
Trust		.282$^{**\ (.000)}$
Subjective Norms		.176$^{**\ (.008)}$

The results indicate that PEOU is significantly correlated with intention to use e-Health services (r = .406, $p < 0.0001$), which suggests that Perceived Ease of Use is negatively correlated to freedom from effort and anxiety. The more users feel anxious and have to put effort into using e-Health, the less likely they are to accept it. The results indicate that the participants prefer systems that are easy to navigate, which is associated with Uncertainty Avoidance. If an e-Health system is not easy to navigate, and the users cannot understand the way tasks are performed, they will feel lost. This may negatively impact on their behavioural intention to accept such services. e-Health systems should be designed in a way that makes them enjoyable and fun to use in order to increase the intention to use.

Technology design is significantly correlated (r = .392, $p < 0.0001$) with intention to use e-Health services. The results suggest that developing a usable, easy to navigate; personalise-able interface design will lead to increased intention to use e-Health services. However, a sophisticated interface will impose unnecessary memory stress on users. Therefore, there is a need to design e-Health system interfaces with a balance between reasonable number of functions and allowing low cognitive load. Balanced interfaces that hide complex functionalities and only make them available on the patient's request are therefore more likely to increase the acceptance of e-Health websites. In other words, the interface should be mapped to the average patient's expectation, while advanced functionalities/features could be accessed based on how much the patient needs to learn or explore.

The results presented in table 2 indicate that trust is significantly correlated with intention to use e-Health ($r = 0.282$, $p < 0.0001$). This suggests that Trust has high influence on participants' intention to use e-Health. This significant correlation indicates that increasing an individual's trust in a system leads to increasing that individual's intention to use e-Health services. Trust is as significant as other technological factors; if users feel threatened or in doubt about the misuse of their personal data, they would be reluctant to provide such information, which in turn would prevent them from using the service. This indicates that Trust can have a negative impact, as the more users feel threatened, the more unlikely they are to accept e-Health services. On the contrary, increasing customers' trust will increase the chance of them accepting the service.

e-Health website services should only ask for personal information if it is perceived as essential by the users. Personal information is always sensitive, so if the patient accesses a chargeable service, great effort should be made to help the patient feel safe about providing their financial information. This could be achieved by displaying the security measure that the site is adopting to safeguard users' details and the transaction.

The results presented in table 2 indicate that Collectivism/Individualism is significantly correlated with intention to use e-Health ($r = 0.195$, $p < 0.0003$). Earlier statistical analysis suggested those participants are more collectivist in nature than individualistic when it comes to their health issues. A majority of the respondents (72.92%) indicated that they prefer to share and learn from others' health experiences, and do not feel threatened by exposing their health-related issues to the wider e-Health community. e-Health websites would benefit from incorporating and facilitating social networking through their online presence, as this may positively influence the users' behavioural intentions to use the service, as they could feel that they are supported by the wider community.

The results presented in table 2 indicate that Power Distance is negatively correlated with intention to use e-Health ($r = -0.188$, $p < 0.0004$). The majority of the participants (54.58%) indicated that they would like to read as much as available about their related symptoms. This suggests that providing less information leads to the system being perceived negatively, which in turn negatively impacts on the acceptance of e-Health websites. As there is high and low culture (Hofstede, 1984), the interface should be able to leverage information provided based on a patient's cultural profile, as having a static interface with either too much or not enough information will affect the overall acceptability of the service. Masculinity/Feminism did not report any significance (r= .142, p < .078). As a result, Feminism does not directly influence I2U e-Health services.

The results presented in table 2 indicate that Subjective Norms are significantly correlated with intention to use e-Health (*r* = 0.176, p< 0.0008). Subjective Norms refer to the influence others can have on someone's intention to commit to an action. The results indicate that Subjective Norms have moderate significant correlation with intention to use e-Health websites where people live and socialise in groups. Subjective Norms cannot be directly modelled in the interface, however; Subjective Norms indirectly associated with intention to use through the effect users can have on another's intention to use e-Health services. The more users are attracted to the service and feel it is useful, easy to use, safe, enjoyable, free from error and that it serves their needs, the more likely they will be to adopt it.

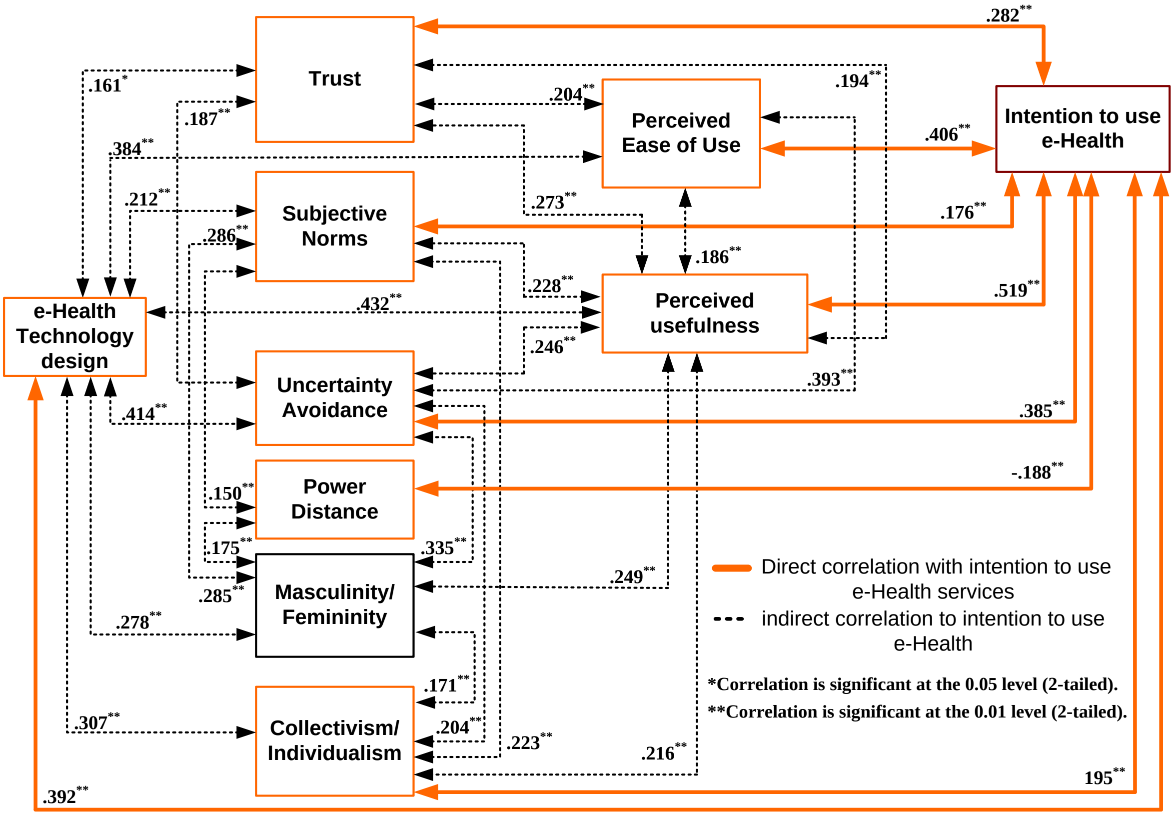


Figure 23: e-HTAM correlation association diagram

Figure 24 shows a graphical representation of the correlation analysis outcome as a refined e-HTAM model. The direct relationship between the model's factors and the intention to use e-

Health is represented by solid lines, while the indirect relationship with the intention to use is represented by dashed lines. In the e-HTAM refined diagram (Figure 24), all cultural factors reported direct significant correlation with intention to use e-Health services, except Masculinity/Femininity dimension.

The above analysis attempts to incorporate cultural factors as design requirements in system design. However, the models discussed are mainly theoretical and lack practical implementation, which to a great extent questions the validity of the results. Moreover, the experiment's results are based on pre-existing websites.

The approach described in this work provides a more realistic and reliable solution for the abovementioned issues, as the solution is based on cultural-personalisation parameters that are embedded into the system, in order to culturally personalise an e-Health web-based service content and interface to suit the patient profile.

3.8.12. A Refined, Culturally Sensitive E-Health Technology Acceptance Model

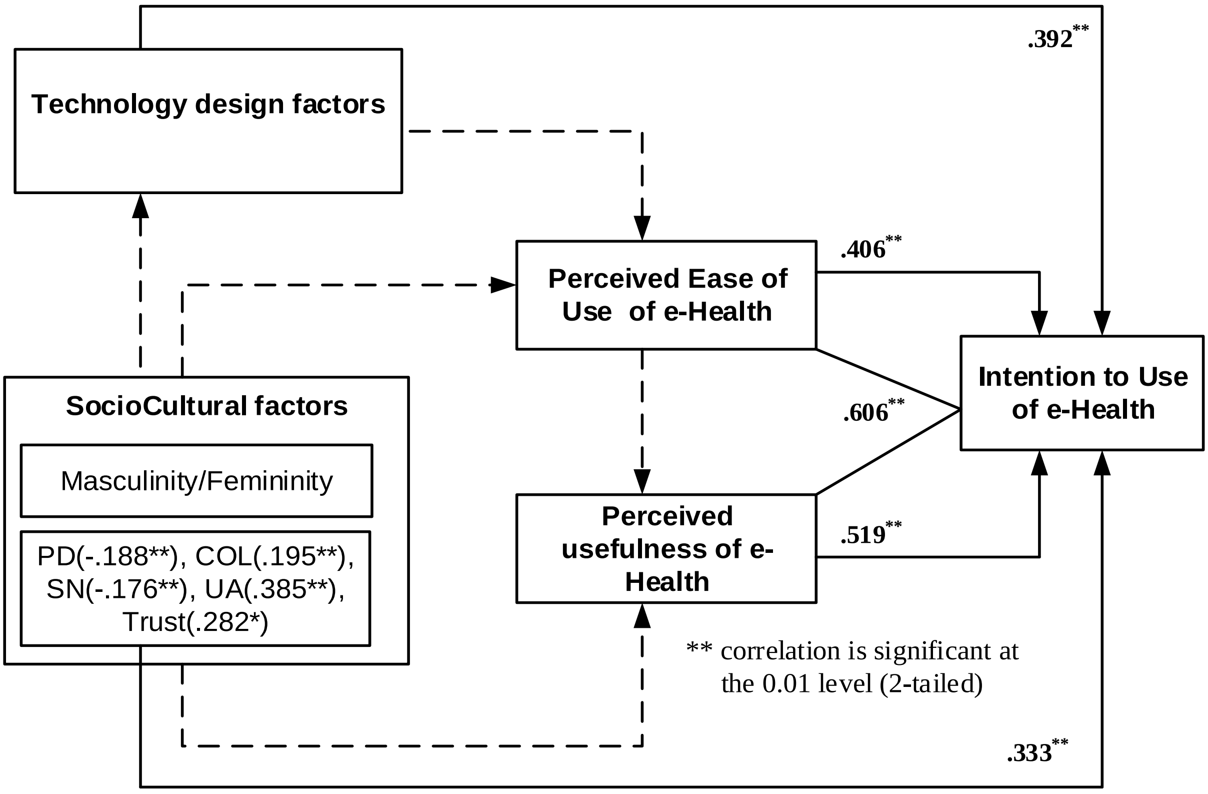


Figure 24: e-HTAM refined Model

The model was refined as shown in Figure 24, which suggests that the implications of cultural dimensions on the interface design of e-Health services could be summarised as:

- **High Power distance** is represented by limited navigation choices, minimal information, focus on the official seal of the organisation, photos, avoidance of errors, limited functionality, while **Low Power distance** is modelled through freedom of navigation, focuses upon high access to information, informative presentation, and emphasises users (and not leaders or organisations).
- **The Power distance** dimension is mapped into interface design as navigation, contents, functionality, symbols, errors and links.
- **Collectivism:** emphasises the organisation, downplays the users, and uses a slogan to emphasise a national or organisational agenda. The screen is filled with a massive political announcement of the organisation/government's achievements, while **Individualism** features an emphasis on the users and their goals, and possible actions they can perform while using the website. The Individualism/Collectivism dimension is mapped into the interface design as ***imagery, colour and language.***
- **Masculinity c**an be modelled by quick results, limited navigation choices, high-level executive views, and goal and work-oriented tasks, while **feminism** is represented by blurring of gender roles, mutual, exchange and support, rather than mastery and winning. The Feminism dimension is mapped into interface design as aesthetics and unifying values used to gain attention and appeal.
- **High Uncertainty Avoidance** is modelled through clear and familiar metaphors, simple, clear articulation, limited menu options, simple and limited navigation controls, precise and detailed feedback of status, simple and clear imagery. **Low Uncertainty Avoidance is** represented by complexity of contents and navigation choices, pop-up windows, multiple types of interface controls, and 'hidden' content that must be displayed by scrolling. Uncertainty Avoidance is mapped into interface design as communication, colour and navigation.

3.8.13. Summary

This chapter has studied the influence technology design and cultural factors can have on users' behavioural intention to accept e-Health web-based services, which resulted in the development of a culturally-aware e-Health technology acceptance model, ‘e-HTAM’, that incorporated Hofstede’s cultural dimensions, Davis’ technology acceptance model, Trust, Tangibility and Subjective Norms factors.

The results’ analysis revealed that Subjective Norms, Power Distance, Collectivism/Individualism and Uncertainty Avoidance, along with Perceived ease of use, Perceived usefulness and e-Health technology design were all of a high significance when designing e-Health web-based services.

To better understand the users and how e-Health web-based service interfaces and contents could be personalised to the patient’s cultural background, and how that can contribute to the acceptance of e-Health web-based services; the next chapter will incorporates the human-computer interaction factors, technology acceptance factors, and cultural factors to investigate, develop and assess a patient-centred Culturally-aware e-Health design approach that will be used to inform the design of a functional proof of concept prototype. The prototype is intended to serve as a means to assess and evaluate the role of patient-centred culturally-aware design approaches on e-Health web-based systems acceptance.

Chapter 4: Patient-centred Culturally-aware e-Health Design Approach

4.1. Introduction

New online e-Health web-based applications have, more than ever before, empowered people to participate more actively in their healthcare process (Barello et al., 2015; Calvillo et al., 2015; Eysenbach, 2001). Bali et al. (2012, p.252) stated that "*Patients today are better informed with access to better information regarding treatment, management and prevention of illness and diseases. Patients have rights to informed consent but also demand informed choice of type and place of their care*". Previous research (e.g. Gomes and Romao, 2015; Baig et al., 2015; Wright et al., 2013; Johnson and Taatgen, 2005) suggests that the actual success of these healthcare applications will depend to a large extent on how effectively people can use them in various cultural and personal healthcare contexts. Human-Computer Interaction (HCI) research has the potential to provide valuable guidance for the design, implementation, and evaluation processes to improve the usability and wider adoption of online e-Health web-based applications. In recent studies, cultural influence on web interface usability has become a significant issue in the HCI field. As discussed in sections (2.3.1, 2.3.2, 2.4.3 and 2.4.4) cultural diversity needs to be accommodated into the design of patient interfaces to enhance acceptability, usability and performance (Huang and Qin, 2015; Ghobadi, 2015; Holston et al., 2016; Khanum et al., 2012; Mohamed et al., 2012). However, a number of issues remain, for example, the theoretical foundation for cultural influences on interface design is confusing and not yet at the level that would allow designers to predict whether culture will have an influence on products, or how these differences can be addressed (Smith and Dunckley, 2007).

This chapter presents a patient-centred Culturally-aware e-Health Design Approach (PCCeDA) for enhancing the cultural awareness of e-Health web-based applications. The proposed solution employs a culturally driven approach to personalise the content and the patient interface according to a patient's profile. We discuss PCCeDA framework, and discuss the proof of concept prototype based on the framework. Finally, we describe the PCCeDA approach to interface personalisation, and show how the concept of culture is represented in the patient interface design.

4.2. General Framework for a Culturally-Aware E-Health System

In this section, we present the general framework of PCCeDA (Figure 25), and consider some basic elements of adaptation in e-Health systems. Our goal is to highlight the main issues and components of the PCCeDA framework. We show which issues, within the framework, are covered in the current implementation.

Figure 25 presents the PCCeDA framework, showing three major components, namely:

1. Stakeholders.
2. Data repositories.
3. Different adaptation plugs.

Stakeholders of an e-Health system include two major groups of users: patient-oriented (patients, their family, and other persons who are receiving different e-Health services but are not medical experts), and medicine-oriented (medical staff, general practitioners, nurses, physicians, etc.). In addition to users, stakeholders include knowledge engineers, software engineers, system architects (developers), administrators, and psychologists. Data repositories contain: (1) various e-Health-related materials, (2) cultural adaptation parameters for the interface, and (3) data that includes a repository of patients profiles and a constructed patient model. Different adaptation mechanisms provide the system functionality and include an adaptation engine, a knowledge base, a patient-profiles engine, a contents delivery engine and an administrative engine.

Our focus is on the adaptation control, which consists of three major parts: a knowledge base, a model (user, task, and environment) generator, and adaptation effect (to contents, to presentation, and to navigation) provider.

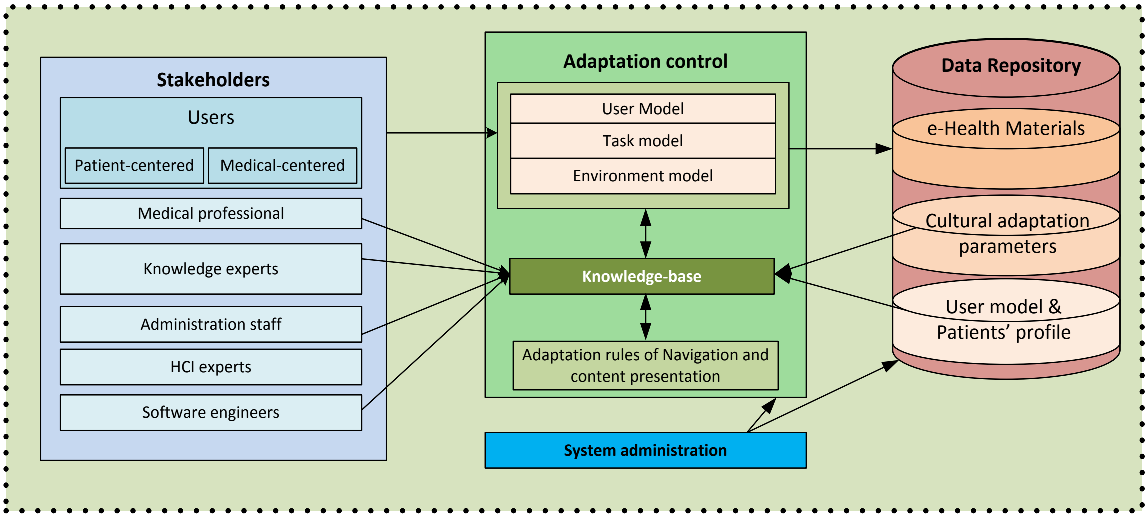


Figure 25: PCCeDA general framework

Personalisation of health information to individual users of e-Health systems is a challenging target because of the large differences that exist among users, including their cultural background, goals, their ability to understand various types of information and their medical interests. Furthermore, in addition to the content personalisation it is important to address the issues of adaptive representation of and navigation through the provided content.

e-Health applications offer many possibilities for these adaptations. In this research, we consider the PCCeDA approach as the key opportunity in addressing the challenges of satisfying different needs of various users in e-Health services.

Our review of recent e-Health development projects and research shows that the issues addressed in the PCCeDA framework still remain open issues in e-Health system design. We found that the current focus on patient-centred culturally-aware research in e-Health is within the stereotype approach to patient modelling that has proven to be very useful for application areas in which a quick but not necessarily completely accurate assessment of the patient's background knowledge is required. Therefore, this approach is aimed at differentiating between main target patient groups of e-Health services.

However, the following are not covered enough in present literature: (1) individual patient interface personalisation of e-Health systems to patient's personal cognitive and learning styles, (2) patient interface personalisation to patient's behaviour, and (3) recommendation of suitable patient interface that is culturally-aware.

In this research context, the proposed interaction between the patient and the professionals (doctors and nurses) is controlled via the web interface, which is equipped with an adaptation mechanism. When the patients contact the doctor/nurse, patients' response will be through the web interface and the response from the doctor/nurse will be fed back to the patients according to their cultural profile.

The communication between the patients and the medical professional is an established field known as Decision Support systems, where web-based or web-enabled clinical decision support systems can automate alerts and warnings, offer physicians instantaneous access to reference materials and standards of care, and help the physician perform compliance checking and maintain a complete, accurate patient medical record.

The use of information technology to enable cross-cultural e-Health systems is currently impractical because there is always a huge gap, which differs across different cultural settings, between how e-Health systems are designed to function and how actually the users interact with them and feel their usefulness in real-life situations.

A central argument of this research is that approaches for modelling e-Health for cross-cultural settings should take on board the well-established system adaptation concepts, which we believe have a potential for taking account of various ways of interaction/responses and for addressing the problem of different cultural settings where the e-Health systems might be used. The following paragraphs highlight the three different levels that can be used to address the interaction between the patients and health professionals.

The reactive mode (blue arrows in Figure 26) is a query-response mode in which the system retrieves information from its knowledge store in response to a clinical query. Often, the information retrieved is enriched and augmented (Anya et al., 2010), to better suit the patient's cultural settings, and to adaptively cache the health information and the navigation style. The reactive mode is a synchronous patient-driven one (patient-machine). One example of this mode of support, as observed in this research, was the tendency of users to seek information from online medical portals. A problem observed with this mode of support is that such web interfaces lack the capability to return culturally-aware information since they assume a generic knowledge of patient context.

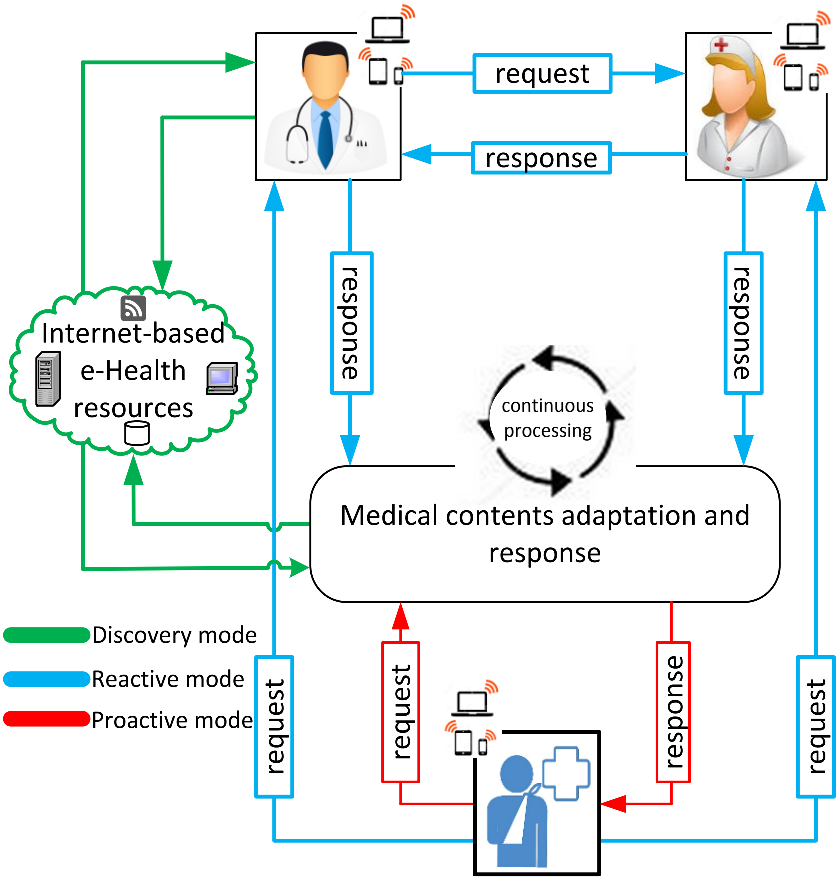


Figure 26: Different states of proposed communication between patients and the medical professional

Proactive mode (red arrows in Figure 26) is a proactive and event-driven mode in which the system detects changes in its environment of use, e.g. in a patient's behavioural interaction. Proactive mode is multidirectional (i.e. person-person and person-machine), and involves both synchronous and asynchronous forms of interaction. An example would be a monitor attached to a patient that sends an alert to his physician about changes in his medical condition, e.g. glucose level.

Discovery mode (green arrows in Figure 26), which is mostly an asynchronous form of interaction, is an event-driven mode in which the system discovers the knowledge generated by professionals, experts, social networks and others who are willing to share their experience. In the discovery mode, the system gathers the health and medical information from such networks, which is then fed as rich content to update the PCCeDA's knowledge domain and to the medical professionals who deal with the patient's request to take an action.

It is worth mentioning that the researcher was the one of the main developers of the system interface and back-end processes of the Context-Aware Multimedia Information System for an e-Health Decision project (sponsored by British Council ID: PMI - RCGS286), where two investigations were running in parallel, one which investigated the problem from the medical professional and decision-making process viewpoint (Anya et al., 2011), while this research focuses on the patients' side and how cultural and HCI issues can contribute to the adoption of e-Health systems.

The following section will briefly highlight the other project where we discussed the proposal regarding the medical staff's interaction in the medical decision-making process.

4.2.1. Designing for Medical Staff Interaction

Anya et al. (2011) carried out an in-depth patient-informed requirements capture to gain an understanding of clinical work practices for designing an e-Health system for cross-boundary decision support. The system architecture includes a conceptual model of practice-centred awareness (PCA) for cross-boundary clinical decision support in e-Health, a technique for adapting suggestions for clinical decision support to the patient's local cultural context, which is referred to as ContextMorph, and an implementation of the proposed model, which is referred to as CaDHealth (Context-Aware cross-boundary clinical Decision support system in e-Health).

According to Anya et al. (2011), CaDHealth (Figure 27) is designed as an advanced web-based system, with secured access and an easy-to-use interface. The architecture consists of knowledge of the domain of work (e.g. diabetes management) with context information about the hospital and the region as well as dynamic information about the given task (e.g. changing status of patient's ill health) in order to build models of work practice. The ContextMorph component is responsible for sharing practice information between patient context and context of the suggestion provider with regard to the given task (Anya et al., 2011).

The suggestion augmentation component retrieves more information from web-based information sources in order to enrich the suggestion provided to suit patient context, and to justify or refute its use. To illustrate how to access CaDHealth, consider a user, such as a clinician or a general practitioner (GP), who requires further information in order to carry out a task, and he has to seek expert opinion from outside of his workplace because, perhaps, experts are not available in his local workplace. The GP can either enter questions (as user queries) to CaDHealth, or have the system automatically detect unresolved issues in his task specification based on known context information. The system has two major sources of information, namely models of work practice, which consist of system-generated work context information, and relevant information retrieved from the web (Anya et al., 2011).

The context extractor is responsible for extracting dynamically changing context data, i.e. the problem-solving circumstances, about a given task. Work practice models of a set of workplaces (for a given task) are stored as context-linked network models. The suggestion augmentation module consists of the information retrieval and analysis module, which retrieves and analyses information from the web and the suggestion profiler, which is responsible for scaling suggestions based on information about their providers. The ContextMorph component is responsible for transforming or matching suggestions based on the work practice information about two workplaces (where the suggestion originates and where the suggestion will be used).

In order to develop the CaDHealth prototype, Anya et al. (2011) further decomposed the three main system components of CaDHealth into sub-components suitable for realisation in a prototype. The work practice-modelling component consists of the domain model builder, the stereotype builder and the context extractor. The domain builder is responsible for generating concepts of a domain of work, e.g. concepts about breast cancer management. The stereotype builders' aggregates data about a workplace, i.e. about the culture and known patterns of working in a place.

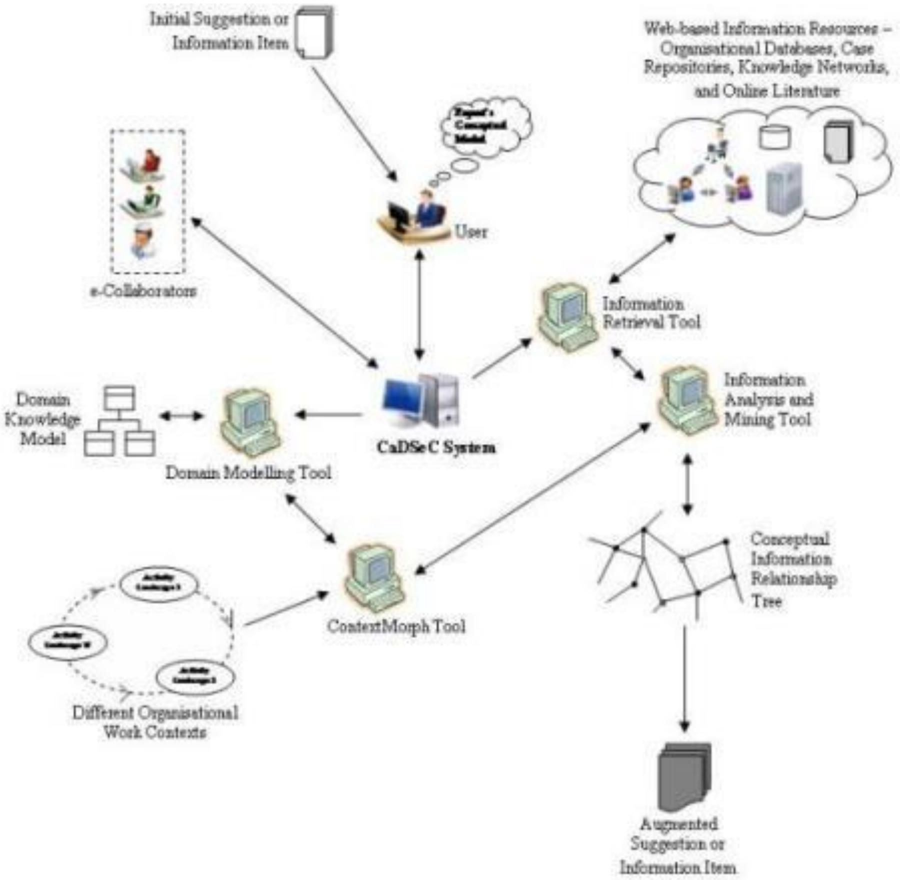


Figure 27: CaDHealth (Anya et al., 2011)

The next sections will thoroughly discuss the various components of PCCeDA for e-Health services from the patients' perspective.

4.3. patient-centred, Culturally Informed e-Health Design Approach

The domains of e-Health, culture, interaction design and technology acceptance were discussed in chapters 2 and 3, and show that technology design and culture significantly impact users' acceptance of e-Health web-based services. The results suggested that navigation, language, images, symbols, communication (feedback), contents, errors, pop-ups, links, and colours along with interface complexity and functionalities should all be taken into consideration when designing for patient-centred, culturally-aware e-Health web-based services.

This research suggests that patient-centeredness in a cultural context could be achieved by employing the cultural-adaptation mechanisms, as they do have the capability of delivering more patient-centred contents compared to personalising the interface based on the national culture of the patient. Google and Facebook, for example, do provide facilities to customise the interface; however, the approach is system-specific, i.e. ‘can only be used by their systems’. While the employment of system-specific adaptation is proved to be efficient for those companies, such adaptation will, for emerging fields and systems, need to be rewritten every time a new system is developed, because there is no sharing mechanism and the adaption is designed for the sole benefits of the specific company.

This research suggests that a more independent and integral approach should be taken to patient and knowledge cultural modelling, where objects are designed as private entities but exposed as public ontologies. Ontologies can provide the means to specify a common understanding of the patient modelling domain, which makes the patient’s ontological object universally accessible (i.e. consumable) to various systems, providing solid grounds for patient-tailored adaptation, which in a way could be related holistically to the usability.

As mentioned in chapters 2 and 3, user centred design approaches have been applied for a while. This research introduces the cultural variables into the design process focusing on the e-Health web-based services domain, in order to make e-Health web-based services more acceptable across various cultures at the patient level. The idea of patient-centred, culturally-aware e-Health spans interdisciplinary research fields typically including usability, interaction design, culture, and technology acceptance that underlie the premise of successful human-computer interaction. Our proposal will be presented in the form of a patient-centred Culturally-aware e-Health Design Approach (PCCeDA), which is a dynamic web-based system that adapts both contents and interface elements to users’ cultural profile. The PCCeDA patient-centric framework diagram (Figure 28) consists of a Patient Model (PM), Adaptation Control (AC), Gatekeeper (GK) and Knowledge Base (KB). The KB is a repository that holds knowledge related to culture and disease symptoms.

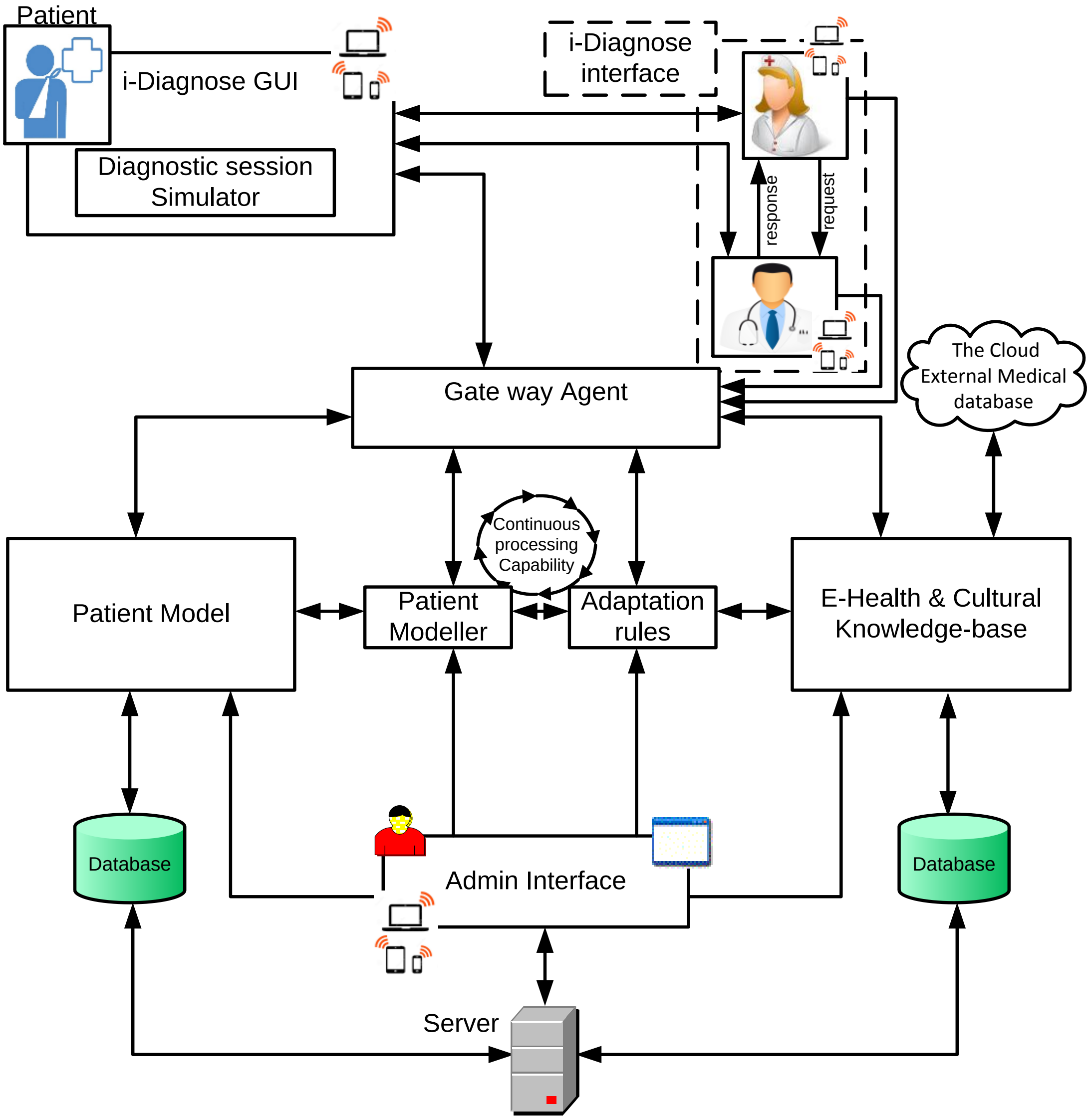


Figure 28: PCCeDA patient-centric framework

The main goal of PCCeDA (Figure 28) is to serve the users based on their cultural markers while adhering to known interaction and usability principles. PCCeDA facilitates the acquirement of the patient's cultural background by taking into account various cultural variables that might affect patient interaction preferences. This information is then saved into the Patient Model (PM). Patients' knowledge stored in the PM will be used by the Adaptation Control (AC) to look up relevant cultural dimensions to personalise the 'initial' interface and the contents in a way that suits the patient. The AC then monitors the patient's interaction behaviours and adapts the interface and the contents accordingly.

In software engineering, objects can be modelled through either static modelling (the objects are pre-assigned values that remain unchanged throughout the lifetime of the system), dynamic modelling (objects are created and assigned value, but the value changes depending on the interaction and other associative objects' state), stereotyping (allows the modelling based on demographical data; this allows predictions about a patient even if there is little information about them), and adaptive modelling (objects, contents and environment are customised based on the individual patient's profile) (Brusilovsky, 2016; Shakshuki et al., 2015; Akiki et al., 2015; Fischer, 2001, 2012, 2013).

This research combines both dynamic modelling and personalisation, as this would allow more up-to-date representation of a patient's current state; the data could be acquired either automatically by observation of the patient's interaction or explicitly supplied by the patient. Changes in the patient's behaviours, progress and overall interaction are captured and applied to the PM accordingly.

4.3.1. The Patient Model

The PM is a distinct feature of PCCeDA; it provides the essential information about the patient to the AC so that contents can be adapted. Informed by the PM, the AC dictates what, when and where a patient can see and access; for example, when a patient navigates through the web pages of a web-based system, the Adaptive Control hides and sorts the contents and links to provide adaptive navigation support. The PCCeDA's PM is continuously updated by the AC, by collecting data by either observing the patient interaction or as a direct input from the patient. The PM stores the knowledge that is specifically related to each patient, which includes their interface preferences, culture-specific knowledge and interaction history.

As illustrated in Figure 29, the PCCeDA proposes a PM that consists of several classes, typically including patient, userControlledInterface, userLanguage, userCulture, userResidence, userAdaptedInterface userDiagnostic and userAppointment. Each serves a specific purpose, which will be explained in the following section.

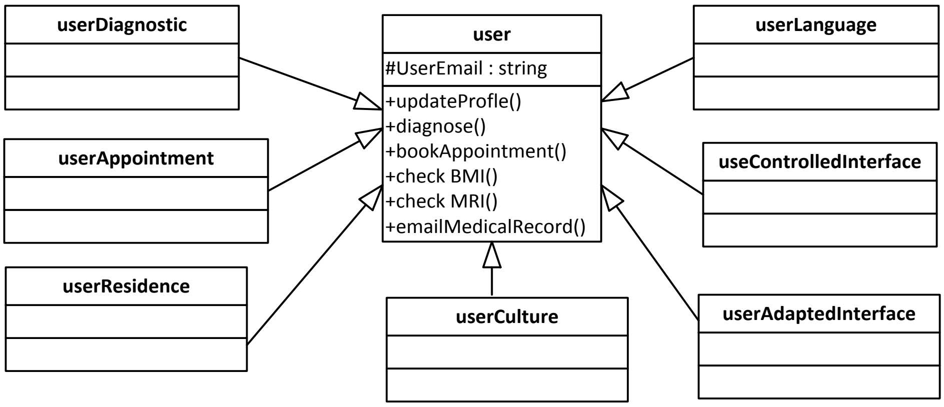


Figure 29: PM aggregation

In Figure 29, the userDiagnostic and userAppointment classes constitute the patient’s health record ‘history’. Collectively, they provide the AC with all the health information that is associated with the current patient. The userDiagnostic class data is obtained as a result of the patient diagnostic process; the data used in the diagnostic process is provided by the medical repository of the KB. The class (Figure 30) relies on a unique attribute ‘key’ called userEmail that identifies ‘distinguishes’ users’ health records, the diagnosticID attribute identifies individual transaction, the diagnosticDate attribute holds the date value of the diagnostic, while the diseaseSymptomID attribute holds the corresponding value of diseaseSymptomsID stored in the diseaseSymptom class.

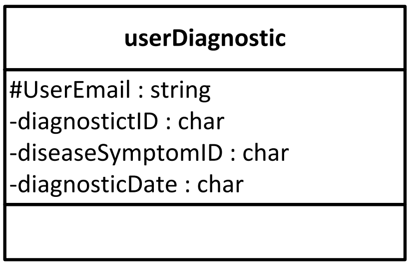


Figure 30: userDiagnostic class attributes

PCCeDA’s userAppoinment class (Figure 31) models the patient’s appointments; it uses userEmail attribute as the primary key. The naming convention adopted is intended to make the purpose of each attribute clearer.

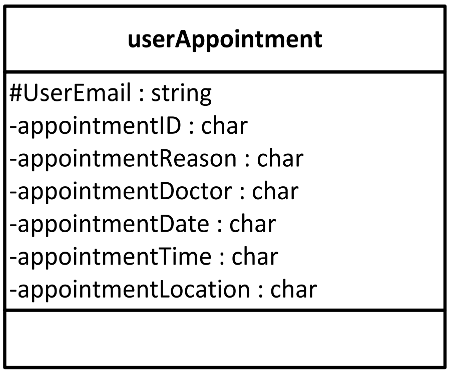


Figure 31: userAppointment class attributes

PCCeDA's userCulture class (Figure 32), userResidence class (Figure 33) and otherCulturalFactors (which provides the state of the trust and subjective norms of the patient, as illustrated in Figure 34) provide the AC with the patient's cultural strings (constraints), which is then used by the AC to tailor the interface and the contents to suit the patient. The userCulture class uses the userEmail attribute as the primary key, while the initialCulturalID attribute is used as a forging key to read corresponding data from the nationalCulture class, which belongs to the cultural instance of the knowledge base.

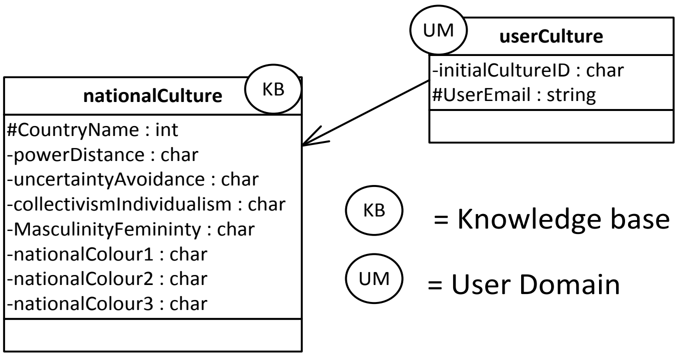


Figure 32: userCulture class attributes

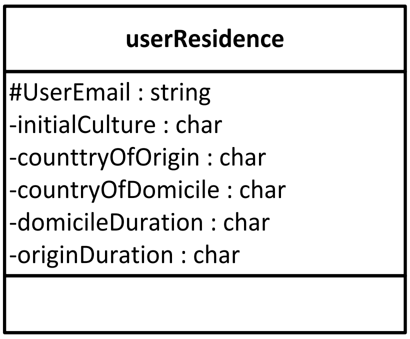


Figure 33: userResidence class

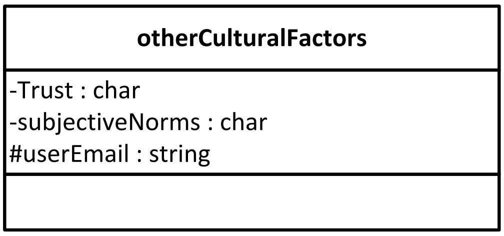


Figure 34: otherCulturalFactors class attributes class

Once the initial cultural state of the patient is formed, the resulting parameters are saved into the userAdaptiveInterface class (Figure 35), which is a core class, as it contains both dynamically and adaptively collected data from the patient. The userControlledInterface class defines the interface colours, fonts and font size. The values can be updated either manually by the patient or adaptively by the AC. The otherCulturalFactors class models the subjective norms (SN) and the trust state of the patient, as a positive increase in the social pressure of the subjective norms and an increased trust state of the patient are very likely to increase the patient’s satisfaction.

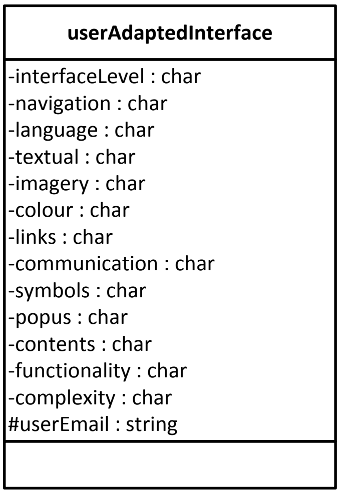


Figure 35: userAdaptiveInterface class attributes

The userLanguage class provides the necessary information to the AC to make a decision on the language that most suits the patient; it takes into consideration parents’ main language, as illustrated in Figure 36.

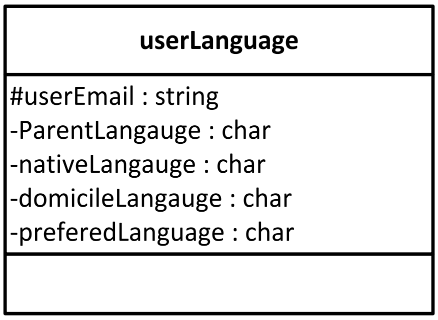


Figure 36: userLanguage class attributes

The patient class (the holistic) holds the markers that are not suitable for other classes. The aggregate patient class (Figures 29 and 37) supplies the AC with all the necessary data to aid the adaptation process.

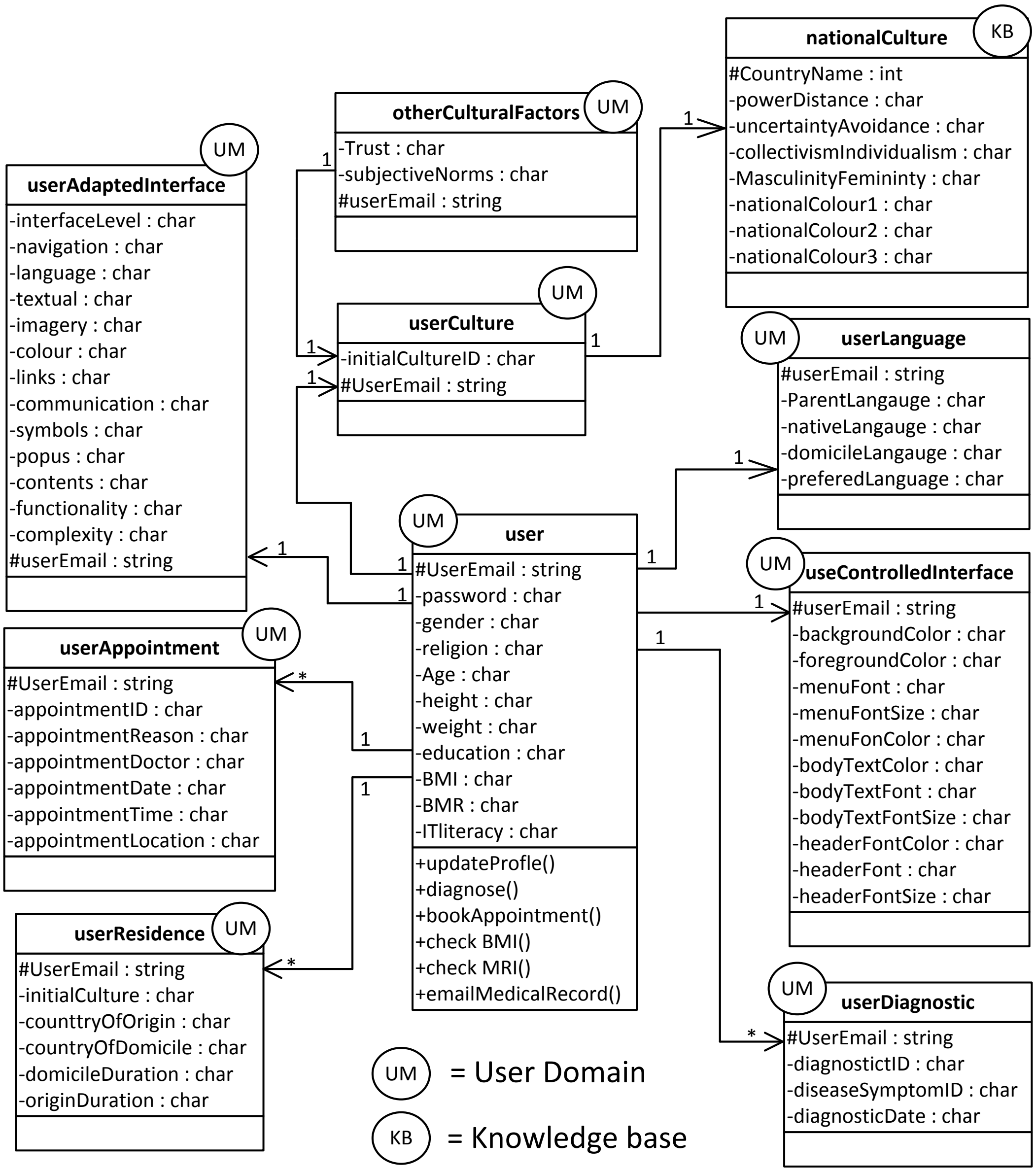


Figure 37: PCCeDA patient model association diagram

The complete aggregated patient instance will be categorised as either Full, Transit or Limited (Figure 38), which is dictated by the AC based on the patient’s cultural orientation. Limited users represent high power distance, high uncertainty, collectivism and masculine countries. They referred to as ‘Limited’ because their cultural orientation suggests that they are only interested in limited information that serves their needs; they do not want to make decisions, and they just want to see the result.

Patients who are categorised as ‘Full’ reflect users from low power distance, low uncertainty, individualism and feminine cultures. They prefer to read all the possible information to educate themselves to make an informed decision or choice. ‘Transit’ refers to users adapting to either side of the possible patient categorisations.

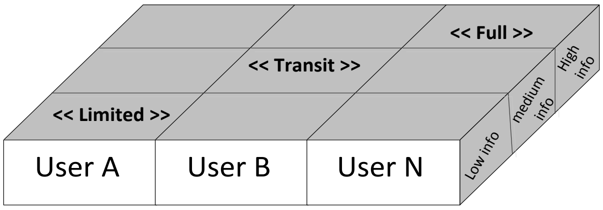


Figure 38: Example of a patient profile state

4.3.2. The Knowledge base

A knowledge base in the information system domain refers to a mechanism for providing a means for information to be gathered, searched and reused. It is available as either a Machine-readable (Mach-R) or Human-readable (Hum-R) knowledge base (Rus et al., 2002).

Hum-R knowledge bases enable the users to retrieve the stored knowledge; they are static in nature, as they are designed to fulfil certain criteria. They are commonly used in applications’ Frequently Asked Questions or help sections, in other words, or in search engines.

Mach-R knowledge bases, from the other end, store knowledge in a computerised format, as this form of storage allows the data to be interrogated for deductive reasoning purposes. Mach-R consists of a set of data; the stored data can be consumed via programmed rules to better describe the knowledge in a logically consistent manner (Rus et al., 2002). Mach-R is very common in the health informatics field, notably the expert systems that facilitate drug prescription or diagnosing; it is also widely used in the semantic web (Berners-Lee et al., 2002).

PCCeDA stores the data in a relational database as a set of formally described tables from which data could be accessed easily. PCCeDA uses MySQL as its back-end database, where the standardised Relational Database Management System (RDBMS) rules are applied to facilitate data storage and retrieval. Knowledge is stored in different related tables; logical operators, such as ‘AND or OR’, are used to concatenate the fragmented data stored in different tables to form meaningful information.

As illustrated in Figure 39, the PCCeDA knowledge base consists of two modules, namely 'nationalCulture', where all culture-specific knowledge and medical-specific knowledge (namely diseases and their symptoms) will be stored.

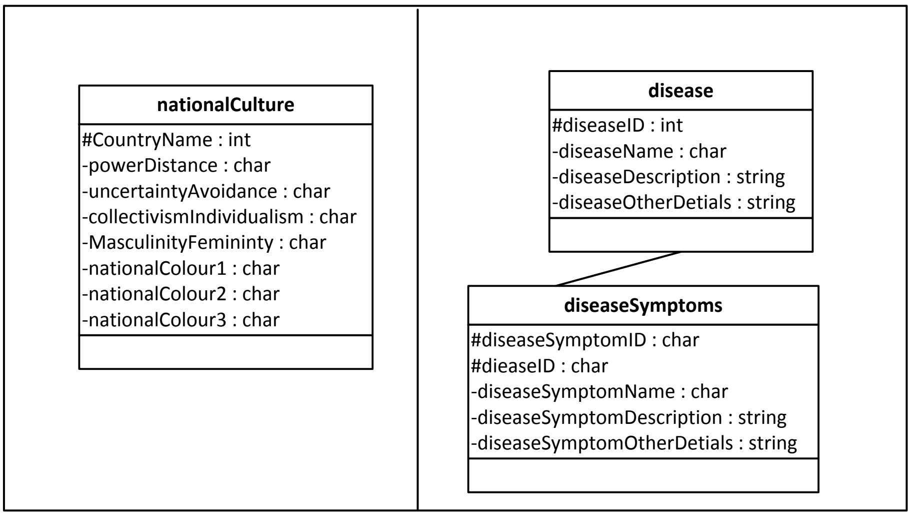


Figure 39: PCCeDA Knowledge base

The nationalCulture instance of PCCeDA holds the national average score for four internationally accepted cultural dimension 'classifiers' (Power Distance, Individualism/Collectivism, Masculinity/Femininity and Uncertainty Avoidance). Those classifiers are designed as low and high values where high refers to high culture and low refers to low culture which is consequently applied to the majority of the world's countries, which are either high or low in each category; the categorisation value is static in nature and does not change in the nationalCulture table.

The AC uses those values to initially configure the interface and contents for the users when they access the system for the first time. The AC observes the patient's behavioural interaction and updates the userCulture and userAdaptedInterface instances accordingly, which makes the class dynamic in nature compared to static values stored in the nationalCulture instance.

Based on the patient's cultural profile categorisation, the AC fetches into the patient's screen the appropriate level of information density, while allowing the patient to read more if s/he opts to do so. Figure 40 illustrates an instance of the knowledge model showing the three levels of a knowledge subject.

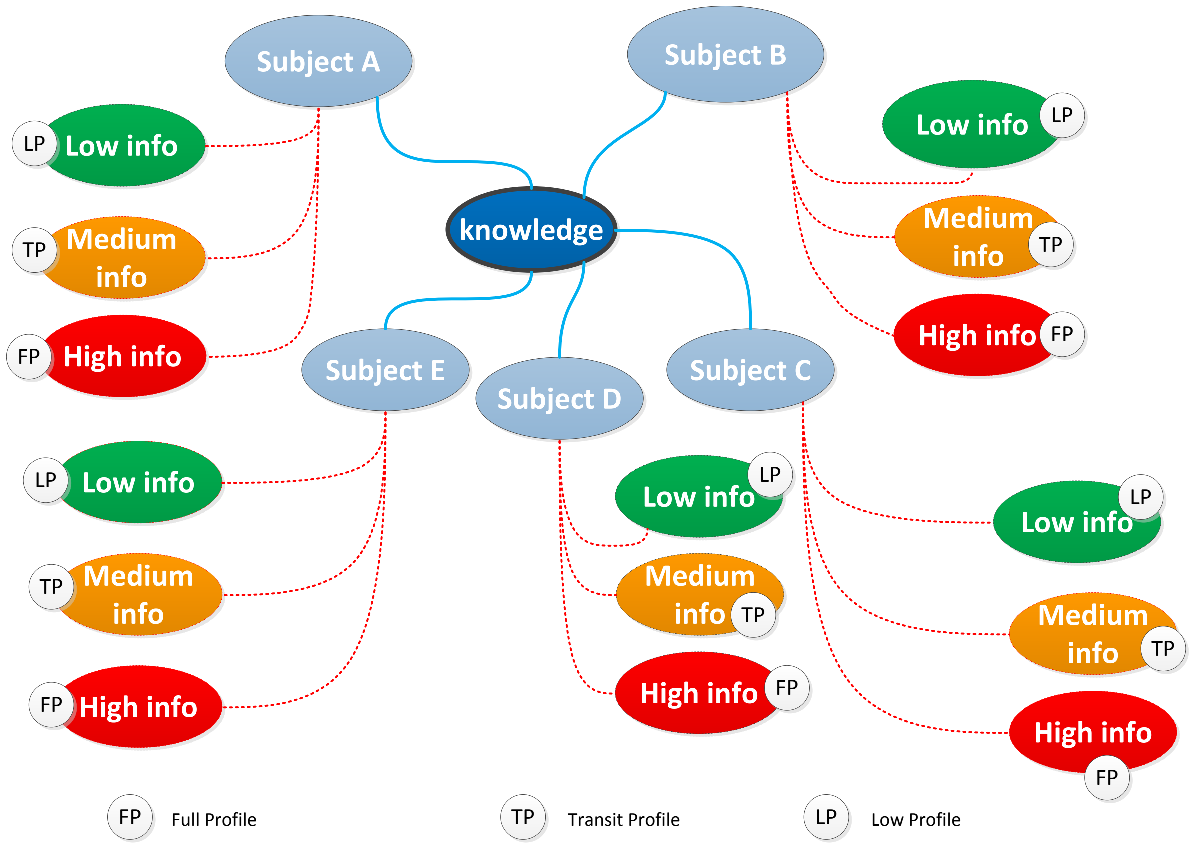


Figure 40: PCCeDA knowledge modelling

4.3.3. The Gatekeeper

The PCCeDA gatekeeper (GK) governs the overall authentication and security process; if the patient is registered it will pull the relevant data and pass it to the adaptation handler. If the patient is not registered, the GK discovers the initial knowledge about the patient by invoking a function to detect the current county; this is done by requesting the patient's IP address from the browser. The current country is then used to temporarily set the communication language and apply the national culture theme to the interface (Figure 41). Once the patient registration is completed, the Adaptive control updates the patient instance in the patient model and updates the interface accordingly. This process ensures that the personalisation process is based on direct knowledge acquired from the patient and automatically by PCCeDA (mapping the cultural profile to Hofstede dimension and extracting data from the Knowledge base accordingly). The GK also allows system administrators to access the back-end of the system (Figure 41).

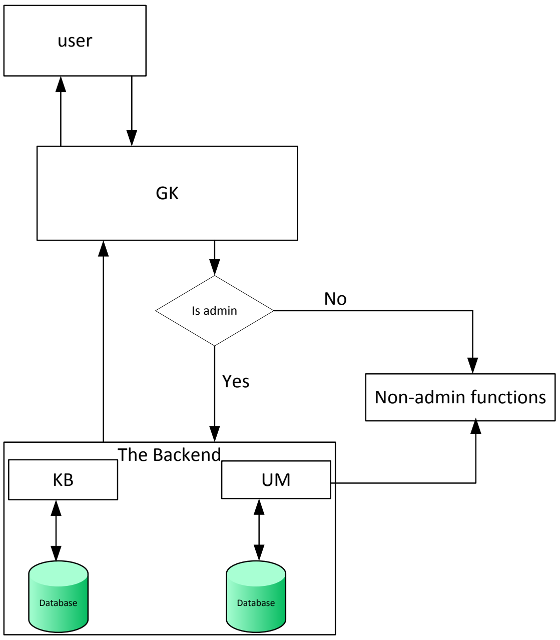


Figure 41: The Gatekeeper

4.3.4. The Adaptation Control

PCCeDA has a personalisation capability that supports the patient environment by configuring the patient interface and presenting contents in a way that suits the users. It can also make decisions based on the patient interaction behaviours, such as when, where and what to be presented to the patient.

In PCCeDA, when a patient makes initial contact with the interface, the Adaptive Control uses the patient’s IP address to detect the country from where the contact is made. Once the country of access has been identified, the matching language will be assigned to the initial contact process. If the language is not the English language, then the Adaptive Control provides a parallel translation in English, being the first international language. The Adaptive Control fetches into the patient’s screen the appropriate density of health information contents and interface elements. When fetching elements into the interface, a button labelled as ‘readmore’ will be made visible to allow the users to click on it if they opted to read more about the specific health topic presented on the screen. When the readmore button is accessed, another button called ‘hide’ is enabled to hide the readmore section enabled as a result of clicking on readmore in the first place. Depending on the level of information the patient can digest, the readmore button accompanies them throughout the interaction process (Figure 42).

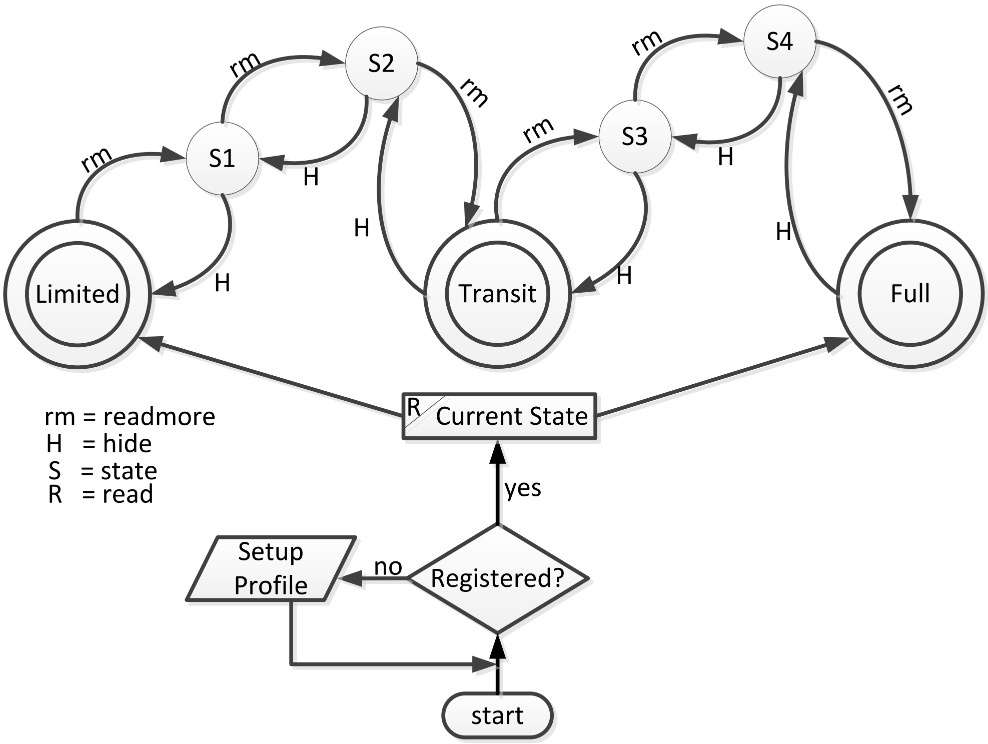


Figure 42: PCCeDA adaptation mechanism

As illustrated in Figure 43, the first objective of the registration process is to determine the most appropriate language for the patient. During the initial acquisition process, explicit demographic data about education, religion and IT literacy will be collected, as it could result in the verification of many assumptions that have been implicitly made during the initial acquisition process by using cultural dimensions.

Knowledge about the patient’s most familiar form of education, for example, can help to adjust the level of support. Hofstede’s dimensions might contradict the patient’s needs in some cases, such as if the PD score is high (resulting in a less complex interface) but the patient has a high level of IT literacy and dealing with complex interface will not be a challenging issue for them. In such cases, explicit feedback from users about other aspects can help refine adaptations.

The process of the initial knowledge acquisition might not be the best for the patient; hence, the ability to refine the interface to better suit the patient, whether through automated adaptation process or manually by the patient, is considered as a further requirement. The Adaptive Control coordinates the framework processes; it updates and interrogates both the patient model and the Knowledge base. When the patient accesses PCCeDA next time, the Adaptive Control retrieves their profile strings from the patient model, which are then used to extract a matching knowledge ‘level’ from the Knowledge base, and present it to the patient.

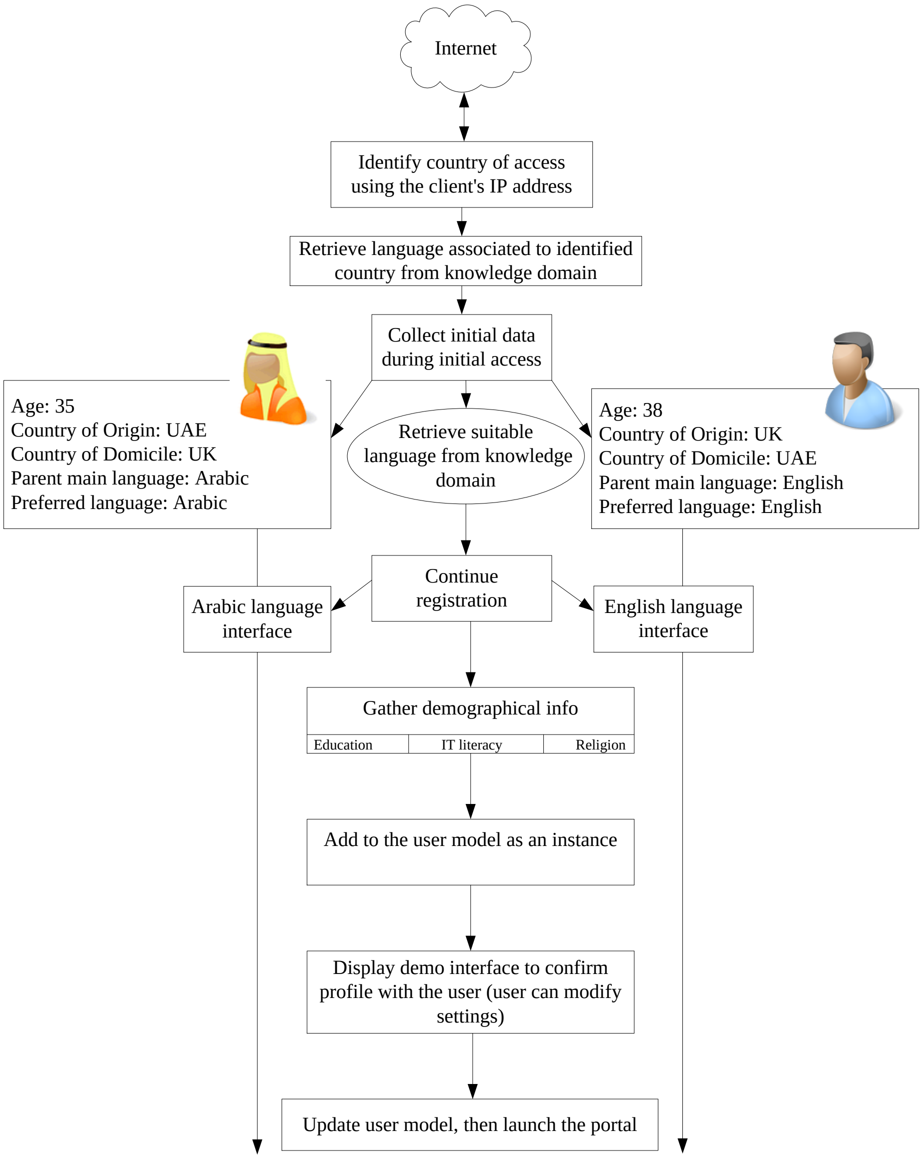


Figure 43: Initial patient contact process

Based on the abovementioned, it could be argued that cultural adaptation is a holistic usability requirement for the interaction between PCCeDA and the users, which can be achieved through a distributed patient model. The next section explains how such information could be stored in an application-independent ontology, and how it can be filled with knowledge about a patient.

4.3.5. Culturally Driven PM Ontology

In information modelling, data is normally stored in containers referred to as databases, which make them application-specific; such an approach limits the possibility of sharing such knowledge stored in them. This applies to patient modelling as well, where the majority of applications create their own patient model due to inaccessibility of other systems' data, or to interoperability issues. Consequently, emerging applications' knowledge about the patient is very much non-existent during the initial patient contact.

This research suggests that a mechanism of a publicly accessible patient profile should be created so other applications can access the profile and customise themselves in a way that suits the patient. One way of achieving this is by developing reusable objects that are available for consumption by other systems and at the same time are continuously updated. This will rapidly increase patient satisfaction, as wherever and whenever they access online applications their preferred setting 'preferences' will be invoked to configure the interface and the contents accordingly.

In a semantics web, such patient-distributed taxonomy could be achieved by adopting an ontology-based design approach (Daraio et al., 2015; Maedche and Staab, 2001; Jiang and Tan, 2009). Ontologies provide the means to specify a common and unambiguous understanding of the patient-modelling domain. Furthermore, they enable the specification of concepts and their dependencies on each other.

Based on the findings from the e-HTAM (Chapter 3), the following two figures were designed to better illustrate and frame the requirements to ontologically model the patient and accordingly the interface.

Figure 44 shows the variables that are non-personalise-able but rather 'to some extent' culture-specific they are considered to be influential as they help set the patient's cultural profile; while Figure 45 illustrates the non-culture-specific, but rather personalise-able, elements that are directly related to usability and interface design.

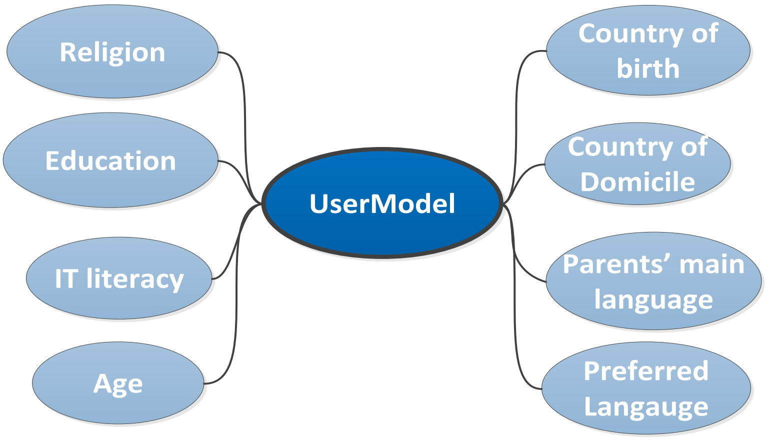


Figure 44: Patient model non-adaptive constructors

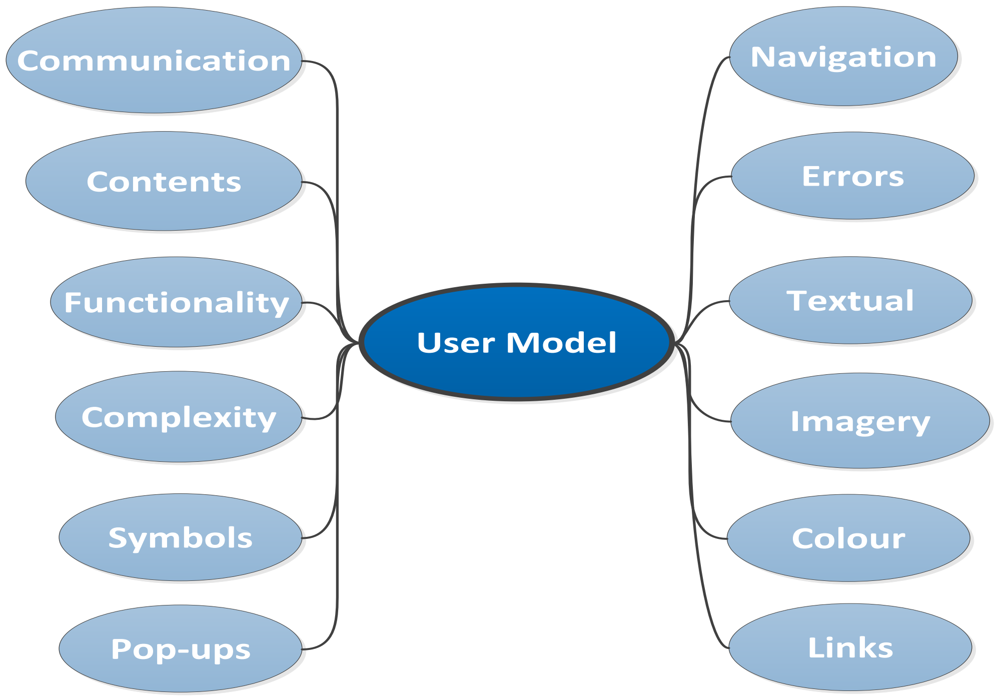


Figure 45: Patient model adaptive constructors

The two figures are then merged together to produce a more holistic figure (Figure 46), which illustrates the variables that will be used to develop the patient model ontology.

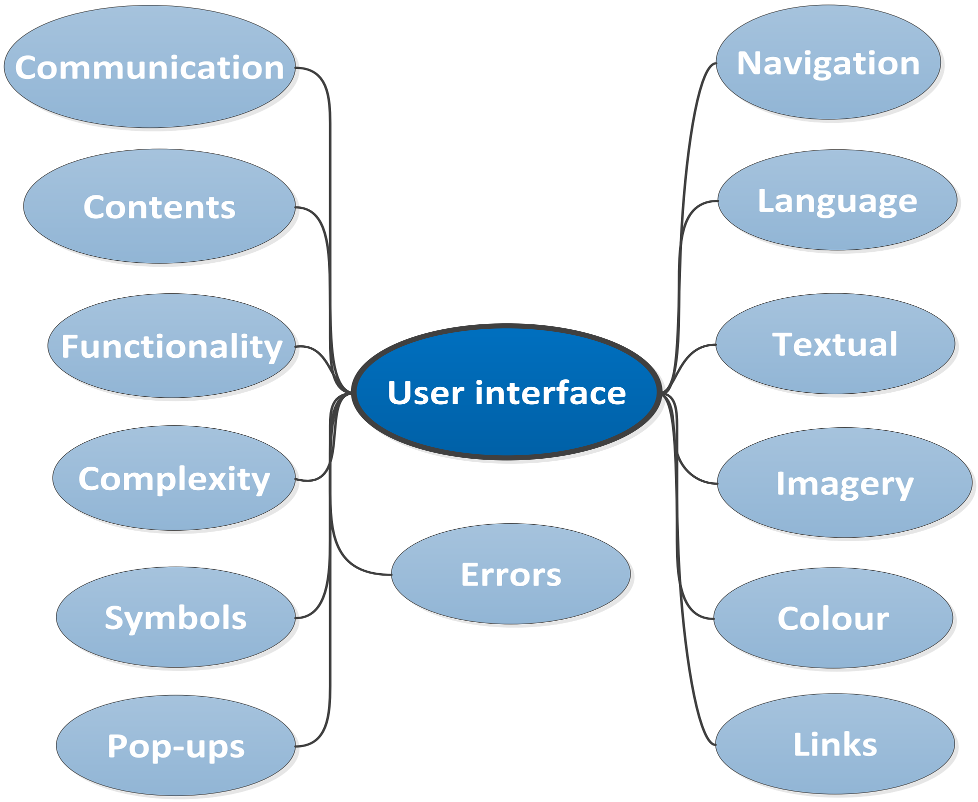


Figure 46: Holistic patient model adaptive components

The holistic patient model (Figure 46) has then been transformed into a class-based Patient Model Ontology (PMO), which has been created (Figure 47 using the Unified Modelling Language UML). A patient's preferences are stored in an instance of the patient class; they are uniquely identified by the ID. The idea is that the patient ID is made publicly available to be consumed by other applications when the patient accesses them. Hofstede's values are directly integrated as a part of the class attributes; this is believed to speed-up customising the interface.

The main concept behind the PMO (Figure 47) is that the interface is customised based on the patient model values. Those values are fed to the instance from both the interface and the culture classes. The culture class holds Hofstede's cultural indexation; they are fed to the patient class based on the impact of the residence class. The residence class is used by the adaptation mechanism to determine the country where the patient mainly lives; the country is then used to set the patient's cultural markers based on the culture class. Those cultural markers are then used by the content and interface classes to provide a personalised interface and content to the patient. The language in particular will be confirmed with the patient before saving the values into a patient profile.

All the classes in Figure 47 are interconnected through data-type properties modelling the patient's background.

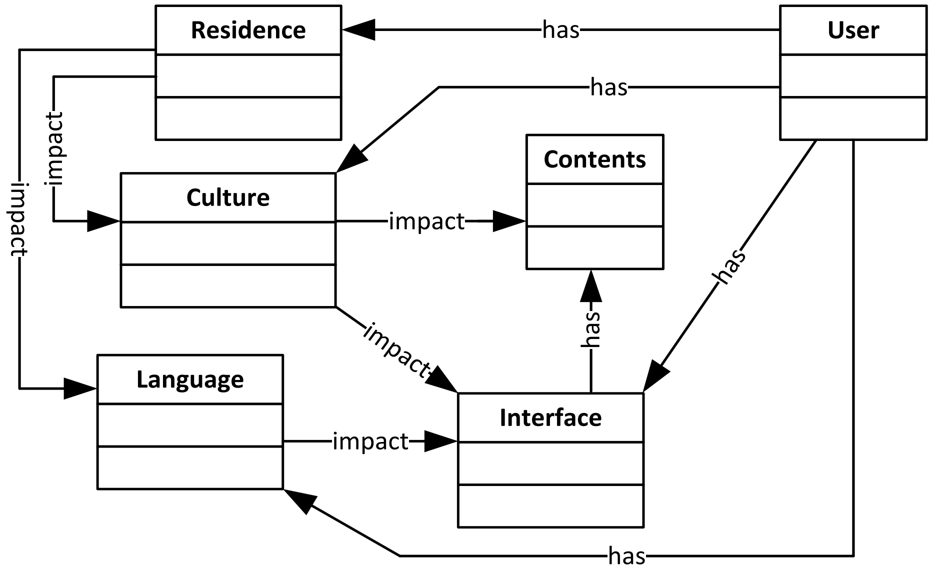


Figure 47: Patient Model Ontology (PMO)

4.3.6. Acquiring Information about the Patient’s Cultural Background

The acquisition of the patient’s origin in the conventional approach to localisation carries the problem that users have to decide in favour of one country, or are initially presented with localised contents based on their IP address. In our approach, information about users is stored in the patient model, which has the advantage that it can contain a more complex model of the patient’s cultural background. This knowledge acquisition can be achieved in both static and dynamically personalised ways. Static knowledge acquisition usually stands for information that is explicitly provided by the patient or obtained from static containers where the knowledge consumed from them is used for all the users and cannot be tailored to suit them. In contrast, dynamically personalised knowledge acquisition describes the process of learning while a patient interacts with the system; it is this dynamically personalised part of patient modelling that accounts for the personalisation.

Naturally, information provided by the patient in a static knowledge acquisition process is the most accurate. There is, however, one major reason why static knowledge acquisition has only limited capabilities and benefits: users generally avoid filling in long questionnaires. While it could be argued that a one-time registration process should be bearable for most people, the benefits of personalised patient interfaces are simply unknown to most users. Thus, many users could hold back from registering if the registration form is very long or looks like an interrogative form. On the one hand, it is crucial to limit the registration process to a minimum. On the other hand, insufficient information about a patient risks the patient-tailored interface and contents not adequately catering for the patient’s preferences, which to a great extent will affect their willingness to use it.

As illustrated in Figure 43, the process of initial acquisition is limited in such a way that it balances the conflict by limiting the questions during the registration to the patient’s age, parents’ main language, origins and country of domicile and the respective life span. Hofstede’s dimensions can then serve as a predictive measurement of the patient’s national culture. The explicit and static knowledge acquisition still risks misjudging the patient’s preferences and abilities. To limit this risk, there is a need to fine-tune the patient profile by monitoring their interaction behaviours and adapting the interface and the contents accordingly.

4.3.7. Knowledge Presentation

The initial acquisition stage will ‘initially’ allow the classification of the patient as either a Limited (patients with high PD), Transit (exposed to more than one culture) or Full (patients with low PD) patient. The patient classification determines the level of the interface sophistication and the density level of the knowledge-related data that will be presented to the patient.

Although this research applies its findings in the health domain, the medical data design and engineering is not one of this research’s scopes; knowledge associated with medical information in the context of this research is gathered from various online health repositories. This knowledge is then fetched into the knowledge domain as three-dimensional array elements, as illustrated in Figure 49. Based on the patient’s profile classification (Low, Transit or Full), an element from the array will be displayed. The patient will have the option to access the rest of the data composition, if they choose to do so, by requesting more information.

Figure 49, also illustrates how various functional elements and their cultural categorisation are modelled and how they will subsequently be presented to the patient according to their profile categorisation. For example, a patient wants to know ‘What is diabetes?’ The information about diabetes which is stored in a three-dimensional array, based on the patient classification data, will be released (fetched) onto the screen. Limited patients will only see the first column of the array, Transit patients will see the first two columns, while the Full patients will see the entire collection (Figure 48).

Diabetes		
Limited patient (low PD)	Transit patient (intermediate PD)	Full patient (high PD)
What is diabetes? Diabetes occurs because the body can't use glucose properly, either owing to a lack of the hormone insulin or because the insulin	**Type 1 diabetes** In type 1 diabetes, the body is unable to produce any insulin. It usually starts in childhood or young adulthood, and is treated with diet control and insulin	**Cure:** Although no cure exists for type 1 diabetes, its symptoms can be eliminated by adhering to a healthy diet that has a controlled amount of sugar in it, and by having regular

available doesn't work effectively. It can be controlled through insulin.	injections. Controlled though insulin injection **Type 2 diabetes** In type 2 diabetes, not enough insulin is produced or the insulin that is made by the body doesn't work properly. It tends to affect people as they get older and usually appears after the age of 40, but increasingly is seen in younger, overweight people.	injections of insulin to replace that which the body is not providing. This aims to keep the blood glucose level steady. Insulin can be short-acting, medium-acting or long-acting. Some people need it twice a day, some three times a day and some use an insulin pen to give themselves insulin just before meals.

Figure 48: Diabetes-related knowledge fetched as a multi-dimensional array object

Similarly, the interface clickable elements are also designed according to the above concept; based on the patient profile categorisation, those elements will be fetched into the interface.

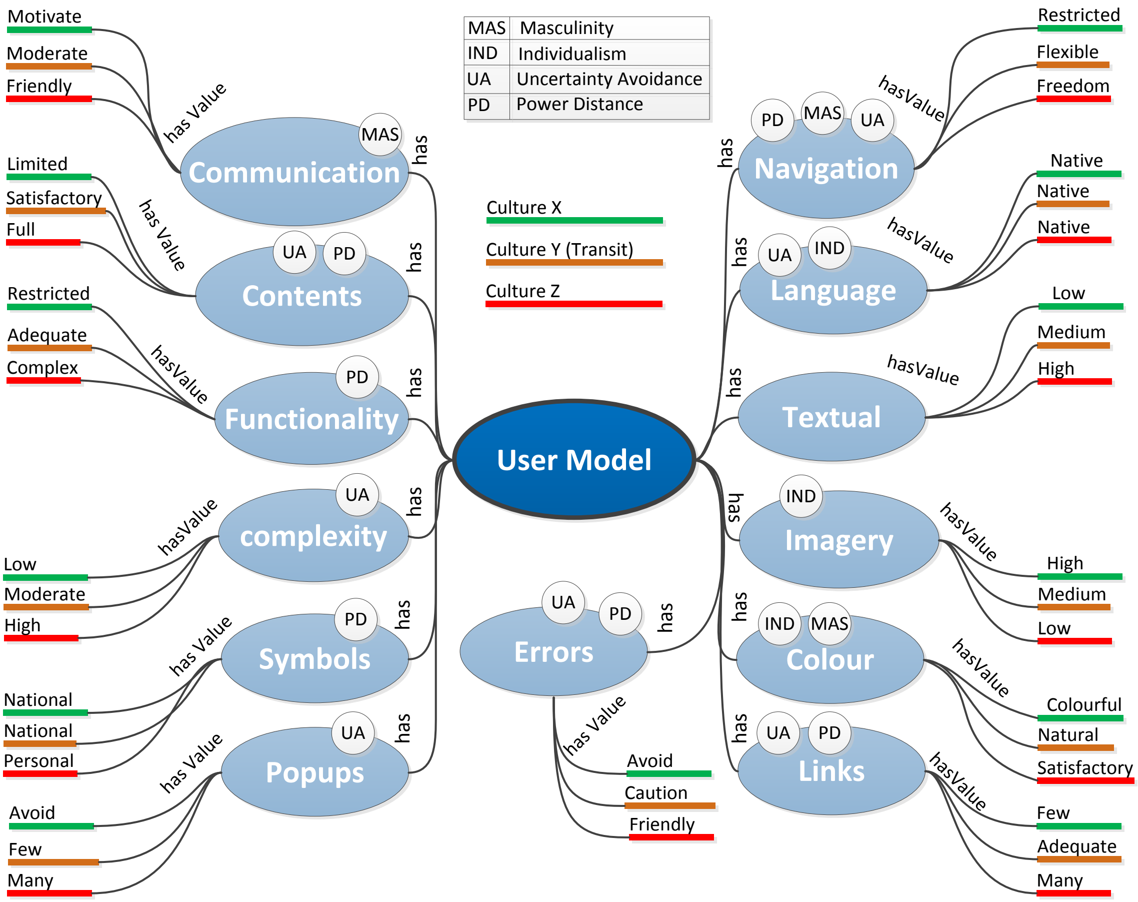


Figure 49: Hybrid Patient Model ontology

4.3.8. Recommending Patient Interface Preferences

While applications similar to our approach are able to present patients with interfaces adapted to their ‘national’ cultural background, which our approach considers as an entry point, patients are initially being presented with an interface based on their national culture categorisation or what is known as cultural indexation (Hofstede, 1984, 2005 and 2010). Although this is thought to be a useful approach, the resulting patient interfaces are not always suitable, as they are based on the patient’s national culture where the patients mainly live. Our approach is more flexible, as it further allows a patient to fine-tune their profile to match her/his ‘dynamic’ cultural preference; this can be achieved either automatically by tracking the patient interaction behaviours or manually adjusted by the patient. In both cases, the Adaptive Control updates the patient’s profile, which subsequently dictates the elements that go into the patient interface, which means that a large number of interface instances can be produced; this ensures that the personalisation is based on the patient-specific dynamic-cultural profile and not on their national cultural attributes.

4.3.9. General Design Guidelines

PCCeDA will adhere to World Wide Web Consortium (W3C) standards (W3C, 2003), while maintaining legal accessibility requirements. Confidentiality will be maintained through authentication, and stakeholders will not be asked to provide their names or date of birth. The data collected will be used for the research purposes only and will not be passed to a third party. Personal data will be stored in accordance with UK (1998) Data Protection Act requirements. Anonymity is maintained throughout the experiment process, and the way data is constructed and stored will not allow the identification of individuals. Participants were made aware of this process via the ethical form that they had to acknowledge before they engaged in the experiment.

Use case

Use cases provide a way to represent patient requirements that are used to inform design. The objective of the patient-centred culturally-aware design approach to requirement specifications is to describe all the tasks that the patients (actors) will need to perform with the system. For reasons of easy exploration and clear viewing, all scenarios that a patient or PCCeDA performs have been captured in tables. A patient case model consists of individual use cases and use case diagrams; each use case is a textual description which collects the scenarios of certain patient tasks. In both theory and practice, the resulting set of use cases will encompass all the desired functionality of the system, because use cases are collections of scenarios of patient and system tasks. Figure 50 illustrates the possible operations, ‘functions’, that a patient can perform using PCCeDA.

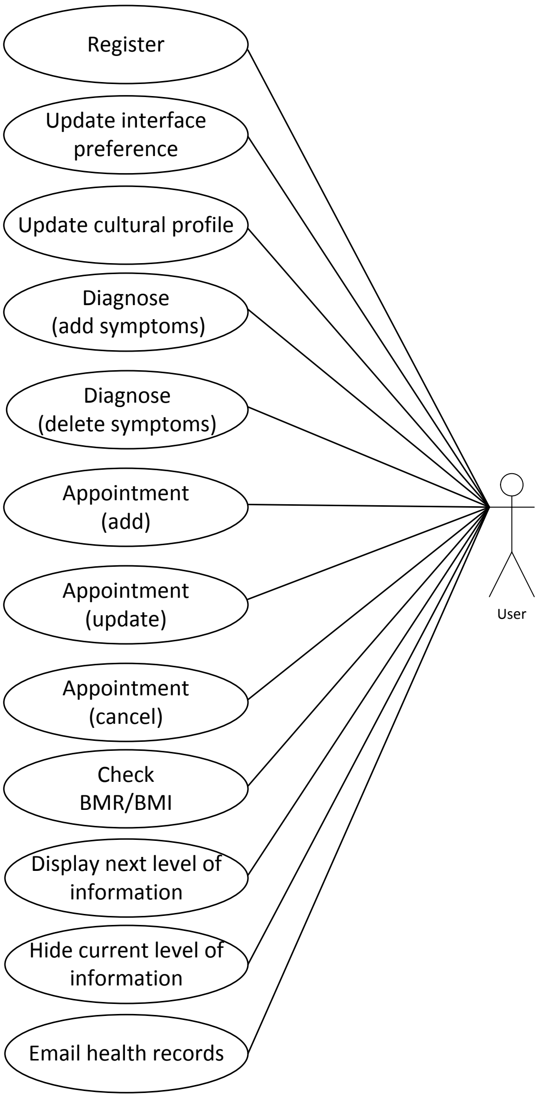


Figure 50: Use case diagram

The following section will describe the above case diagram.

Name	Check registration status
Use case no.	(1)
Actors	patient
Entry condition	None
Flow of events	1. Patient entered patient and password 2. PCCeDA checks the registration status 3. If the patient is not registered, they will be forwarded to registration screen (use case 2) 4. If they are registered, they will be forwarded to PCCeDA main screen

Exit condition	Patient registration status checked

Name	Registration (capture cultural strings)
Use case no.	(2)
Actors	patient
Entry condition	First time to use PCCeDA (click on registration button)
Flow of events	1. PCCeDA displays registration form ‘screen’ 2. PCCeDA asks the patient about the current and previous residence, parents’ language, age and religion 3. Patient provides (email address, password, age, country of origin, country of domicile, years lived in each country, education, parents’ main language and religion) 4. PCCeDA saves the patient profile and forwards the patient to login screen
Exit condition	Patient initial cultural profile captured

Name	Diabetes diagnostic
Use case no.	(3)
Actors	patient
Entry condition	Registered patient
Flow of events	1. PCCeDA displays login screen 2. Patient provides email address and password 3. PCCeDA checks the registration status 4. If the patient is registered, they will be forwarded to PCCeDA main interface 5. If the login failed, PCCeDA will display message and allow the patient to re-enter their details or register if they are not registered (use case 2) 6. PCCeDA Adaptive Control configures the interface according to the patient’s profile 7. Patient will be provided with list of symptoms related to diabetes 8. PCCeDA assesses the symptoms and advises the patient accordingly 9. Depending on the patient profile category (Limited, Transit or Full), relevant information about the symptoms will be displayed

Other dependant related operation	Patient can amend or delete symptoms
Exit condition	Patient symptoms captured, diagnosed and relevant information returned to the patient

Name	Make appointment
Use case no.	(4)
Actors	patient
Entry condition	Registered patient + previously diagnosed
Flow of events	1. PCCeDA displays login screen 2. Patient provides email Address and password 3. PCCeDA checks the registration status 4. If the patient is registered, they will be forwarded to the PCCeDA main interface 5. If the login failed, PCCeDA will display message and allow the patient to re-enter their details or register if they are not registered (use case 2) 6. Adaptive Control personalises the interface according to the patient's cultural profile 7. Patient clicks on make appointment, then selects a date from the calendar 8. Patient will have the option to select whether they see a male or female doctor 9. Appointment confirmed by a message displayed on the screen and through patient's email
Other dependant related operation	Patient can amend or cancel appointment
Exit condition	Appointment made

Name	Check Body Mass Index (BMI) and Body Metabolic Rate (BMR)
Use case no.	(5)
Actors	patient

Entry condition	Registered patient
Flow of events	1. PCCeDA displays login screen 2. Patient provides email Address and password 3. PCCeDA checks the registration status 4. If the patient is registered, they will be forwarded to PCCeDA main interface 5. If the login failed, PCCeDA will display message and allow the patient to re-enter their details or register if they are not registered (use case 2) 6. Patient to click on check BMI 7. PCCeDA calls the patient's age and gender from the profile 8. Patient enters their weight and height (PCCeDA will use cultural-related units, i.e. kg or lbs and cm or feet/inches) 9. Patient describes (through selection) their daily activity 10. PCCeDA calculates BMR and BMI based on the supplied information, and provides feedback about patient's daily calorific needs and indicates whether the patient is normal or overweight
Exit condition	BMI and BMR checked and relevant information displayed to the patient

Name	Email health records
Use case no.	(6)
Actors	patient
Entry condition	Registered patient
Flow of events	1. Patient enters patient name and password 2. PCCeDA checks the registration status 3. If the patient is not registered, they will be forwarded to registration screen (use case 2) 4. If they are registered, they will be forwarded to PCCeDA main screen 5. Patient clicks on email my health records 6. PCCeDA gathers and emails the records to the patient 7. A confirmation message is displayed on the screen
Exit condition	Patient's records are emailed and confirmation message is displayed

Name	Edit cultural profile
Use case no.	(7)

Actors	patient
Entry condition	Registered patient
Flow of events	1. PCCeDA displays registration form 'screen' 2. PCCeDA asks the patient about the current and previous residence, parents' language, age and religion 3. Patient clicks on edit settings 4. Patient can change country of origin, country of domicile, duration in each country, age, education, religion, parents' language and preferred communication language.
Exit condition	Patient cultural profile amended and saved

Name	Update interface preference
Use case no.	(8)
Actors	patient
Entry condition	Registered patient
Flow of events	1. PCCeDA displays registration form 'screen' 2. PCCeDA asks the patient about the current and previous residence, parents' language, age and religion 3. Patient clicks on edit settings 4. Patient can change background colour, text colour and font size
Exit condition	Patient profile amended and saved

Name	Hide current level of information
Use case no.	(9)
Actors	patient
Entry condition	Registered patient and element in question to be visible, and is not the first level of the information for the current symptoms
Flow of events	1. Login 2. Access an item that has sub-items 3. Click on hide to hide an item
Exit condition	Element hidden

Name	Display next level of information
Use case no.	(10)

Actors	patient
Entry condition	Registered patient and element in question is not visible
Flow of events	1. Login 2. Access an item that has sub-items 3. Click on readmore
Exit condition	The next level of information is revealed to the patient

Non-Functional Requirements

Non-functional requirements tend to deal with criteria that can be used to judge the operation of a system, rather than specific behaviours, but are in contrast to the functional requirements that define functions and behaviour. In broad terms, they are associated with usability, performance, documentation, environment, reliability, security and audit (Wiegers, 2003).

Functional Requirements

In software engineering, functional requirements are a means to specify a system's particular services, and the results available through the system (Phillip, 2007).

As noted earlier, PCCeDA is designed as a proof of concept; the following functional requirements are intended to serve as general design guidelines to be further expanded during the development stage.

–PCCeDA should provide a facility for the patients to check whether they are likely to be diabetic or not.

–PCCeDA should be able to compose the patient's cultural profile.

–PCCeDA should be able to track and record the patient interaction.

–PCCeDA should be able to personalise the interface and contents according to the patient profile.

-PCCeDA should allow the patients to adjust their profile.

–PCCeDA should allow the patient to book and cancel appointments.

–PCCeDA should allow the patients to check their BMI and BMR.

–PCCeDA should allow the patients to email their health records to their personal email address.

Interface Requirements

PCCeDA is web-based and can be used to design an application that is suitable for PCs, Personal Digital Assistants, laptops and other mobile devices that are Internet enabled. PCCeDA provides the patients with a help facility while they are using the system.

Good usability practice interface consistency, feedback, help that minimises memory overload will all be taken into consideration in developing PCCeDA.

4.4. i-Diagnose: a patient-centred Culturally-Aware E-Health Web-based Application for Diabetics

In this section, we present the ‘i-Diagnose’, a system prototype developed based on the PCCeDA framework, and which consists of a patient model, Adaptive Control and a knowledge base. The primary functionality of i-Diagnose lies in the fact that it is culturally adaptive in nature. It dynamically customises the interface and the contents in a way that fits individual patients. i-Diagnose is the first to apply both TAM and Culture in a patient-centred e-Health web services study.

i-Diagnose is a web-based, patient-centred Culturally-aware e-Health system for diabetic people. It allows the patients to check if they are likely to be diabetic, book appointments, check their BMI and BMR, and to access their health records, often through email.

As a proof of concept for this research work, i-Diagnose is informed by the findings from the e-HTAM (Chapter 3) and the findings of the literature review in chapter 2. The main objective of i-Diagnose is to investigate and assess the effectiveness and usefulness of integrating culture into a technology acceptance model, and how that integration would make the e-Health web-based services acceptable across various cultural settings. While i-Diagnose specification articulates the requirements to fully integrate the measurable cultural variables and technology design factors, it is important to clarify that only key functional features and data models are implemented in the proof of concept. The section first discusses the requirements for i-Diagnose and then introduces the relevant details regarding its implementation and functionalities.

4.4.1. System Requirements

The primary goal of i-Diagnose is to automatically personalise the interface and the contents to suit the patient. The initial state of the patient profile will be semi-automated; as patient input is required during the initial contact with i-Diagnose. After the initial data acquisition, the personalisation is formulated by observing the patient's behavioural interactions. In both cases, the i-Diagnose interface should be flexible to tailor itself to the patient's needs while allowing the patient to access the extra features of the interface.

To study the effectiveness of the patient-centred culturally-aware design approach, i-Diagnose should have two versions, one that is equipped with cultural and technological features, and another that is non-adaptive, non-dynamic and not culturally aware. Comparing the effectiveness of the two versions is expected to shed light on the role of culture in e-Health web-based services acceptance. The functional elements that will be used to develop i-Diagnose are depicted in Figure 49, where the cultural factors are integrated as measurable elements 'objects' into the ontology, which will help define all system and interface design elements. The figure shows exactly how each object is modelled and the restriction that goes with it.

4.4.2. Technology Used for the Prototype Development

i-Diagnose is a dynamic web-based application that requires a server, a database and a scripting language. This combination can be served by the use of PHP (as programming language) and MySQL (as database) that runs under Apache (as web server). i-Diagnose also requires client-side technologies, in particular JavaScript (to serve validation), Extensible Hypertext Mark-up Language (XHTML) (to present feedback to the patients) and (CSS) Cascade Styling Sheet (to control the elements and the presentation style), enabling the systems to run from the client's computer. The following will justify the selection of the stated technologies.

Although there are many server-side dynamic scripting languages typically including PHP, Java Server Pages (JSP), Active Server Pages (ASP), and Python, PHP, JSP and ASP are the most popular in the field of web-dynamic programming.

JSP is a Sun Microsystems development; its advantage is that it uses servlet, which is a Java class, to extend the server capabilities. JSP is very common amongst companies who use the Internet as their vehicle. Despite it being a powerful enterprise solution, the language is known for its complexity of use (Figure 51), and requires servlets at the client's side.

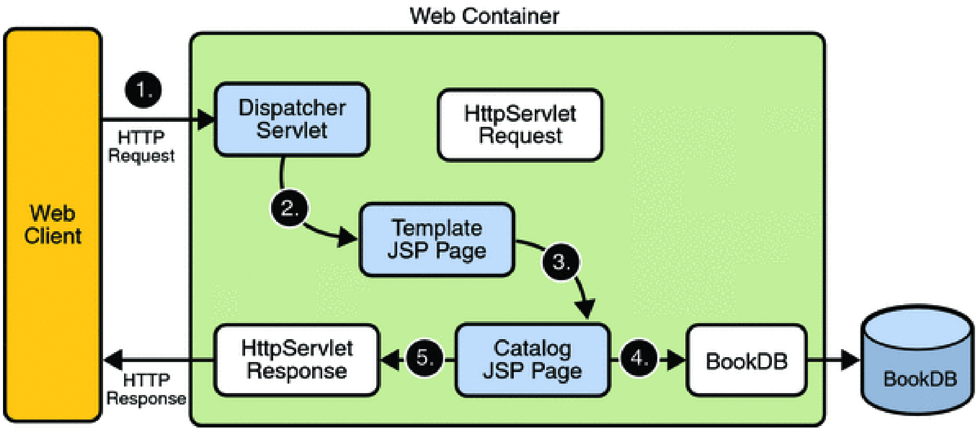


Figure 51: Java server technology (Oracle.com, 2015)

ASP is a .net family member, which further empowers the capability of dynamic programming, as .net facilitates the use of more than one language in web-based systems development. ASP is natively designed to work with MSSQL.

PHP (Hypertext Pre-Processor), on the other hand, is a popular Internet scripting language, as its object-oriented language, based on C++, is easy to use and an open source platform. PHP is widely supported by open source communities, including its Apache friends. They have put together an open source cross-platform web-based server package that consists of Apache, PHP and MySQL.

XAMPP (X server operating system that runs Apache (A), MySQL (M) and support PHP (P) and Perl (P)) is a package that is compiled by the Apache friends community, which consists of Apache server, PHP and MySQL.

XAMPP was chosen to develop i-Diagnose, as its combination precisely represents the technologies needed to develop i-Diagnose. Nonetheless, the fact that XAMPP is an open-source licence means that it is a powerful combination of technologies and is supported by Apache-friends community, which further cemented its selection. The combination is graphically represented in Figure 52.

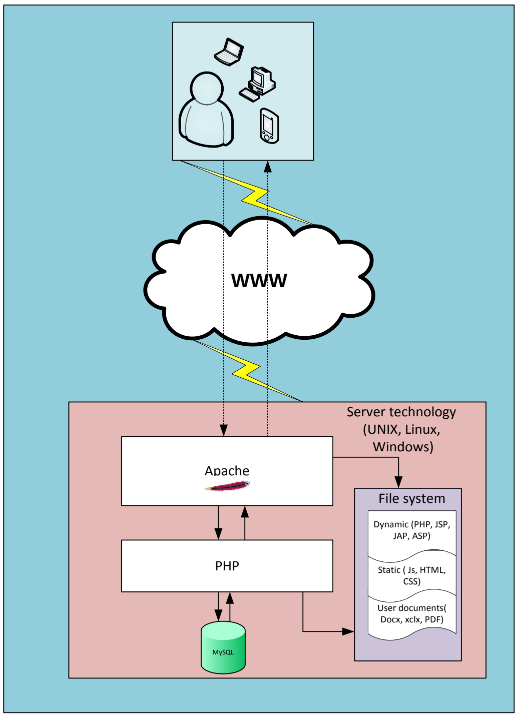


Figure 52: i-Diagnose development technology architecture

One of the main features of i-Diagnose is the ability to adapt to the patient’s preferred language. This feature caused severe technological challenges, as the researcher initially thought that the Google translation Application Programming Interface (API) service would serve this requirement. The integration was successful; however, during the initial i-Diagnose test, the translation provided by Google API was inaccurate and, to some extent, misleading when translating from English to Arabic and vice versa (Appendix A, pseudocode 10).

The alternative was to develop a system with a specific translation service, which was considered ‘out of boundary’ of the requirements for i-Diagnose. The interim solution adopted in i-Diagnose was to design objects in a multi-dimensional array. The preferred language used by the patient will then be used to call the corresponding element from the array (Figure 53). As a proof of concept, only Arabic and English were made available at this stage of the prototyping.

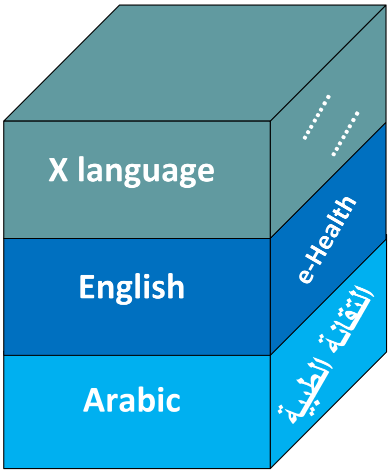


Figure 53: Multi-dimensional array representing different languages

4.4.3. Exporting the Patient Profile as an Ontology

In order to make the patient profile accessible by other online applications, the patient instance will need to be in a known format; there are many international formats that other systems can consume, such as Resource Discovery Framework (RDF), Web Ontology Language (OWL) or Extensible Mark-up Language (XML) schema.

RDF can only be consumed by parsers that are designed for RDF, and the same applies to OWL, which makes it necessary to represent the patient model as both an RDF and OWL object; however, XML schema is internationally acceptable as it provides the data type ‘field’ definition and the value of the field, which are more or less what RDF and OWL objects will provide. Based on that, i-Diagnose makes the patient instance available as OWL, RDF and XML schema. Pseudocode 1 (Appendix A) illustrates the mechanism of converting the patient instance elements to XML schema; PHP script was used to write the script to export the patient instance as OWL and RDF.

4.4.4. Serving Personalisation Rules

As discussed earlier in this chapter, i-Diagnose patients will initially be classified according to their national culture, which is based on Hofstede dimensions (Hofstede, 1984) that have a low score of 0 and a maximum score of 100. In Hofstede index score-line, if a score is under 50 for power distance and uncertainty avoidance, then the culture scores relatively low on that scale and if any score is over 50 the culture scores high on that scale. A culture that score under 50 is considered Feminine and collectivist culture.

The classification of patients based on the Hofstede 'scale' will generate a number of possible interface versions; nevertheless, the fact that they might not accurately model individual patients further escalated the need for an adaptive mechanism to better model the patients based on their individual state.

To set an entry point to i-Diagnose, the patients' national cultural profiles will be used to classify them before passing their parameters for personalisation; the initial classification is either Limited, which represents patients from high power distance, high collectivism, high uncertainty countries, or Full, which represents the other end of the classification, as represented in Figure 54.

Patients who are at the left end of the scale, 'Limited', will be provided with limited interface options, as denoted by the labelling of their state as 'Limited'. Patients at the right end of the scale will be provided with 'Full' functionality, as they are categorised as low in power distance, collectivism, femininity and uncertainty avoidance.

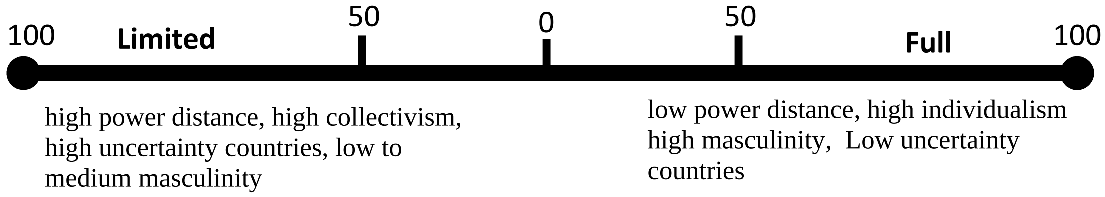


Figure 54: Hofstede (1984) Cultural scale

The Adaptive Control will dictate the level of interface complexity and the density of information, which are informed by the patient's 'position' on the scale illustrated in Figure 54, which is either Limited, Transit or Full.

The following section illustrates how patient interactions impact their profile classification. Two extreme scenarios will be used, one represents a patient's initial classification as 'Limited' and the other is classified as 'Full'; they will both traverse to the other side of the scale illustrated in Figure 54.

Saeed (40 years old) is a patient from UAE who speaks Arabic as a native language and has lived in the UAE for 20 years. John (40 years old) is a native British citizen who speaks English as a native language and has lived in the UK for 20 years. Both of them decided to use i-Diagnose to check if they are likely to be diabetic.

When they type in the Uniform Resource Locator of i-Diagnose, they will be promoted to either sign in or register to use the server (Appendix B: Figure 80).

As illustrated in Figure 81 (Appendix B), the initial contact with i-Diagnose requests some information to be provided by the patient. i-Diagnose will request information to form an initial assumption about the patient's cultural background.

The country of access is detected by the function get_country_name function, as illustrated in (Appendix A, pseudocode 3).

As stated above, the acquisition of the patient's origin in the conventional approach to localisation carries the problem that patients have to decide in favour of one country, or are initially presented with localised contents based on their IP address. The initial knowledge acquisition is achieved in both static and dynamically adapted ways. Static knowledge acquisition explicitly asks the patient to provide information to aid their initial cultural classification, such as parents' language, religion, age, country of origin, country of domicile, gender and education level (Appendix B, Figure 81). At the end of the registration process, the patients will be asked to confirm their preferred communication language.

Upon completion of the registration, i-Diagnose sets the default communication language and cultural markers of Saeed and John to UAE and UK respectively.

Saeed and John's origins influence their individual interfaces and content customisation. Figure 55 illustrates the score for UAE culture based on Hofstede indexation.

Based on Hofstede's (1984) cultural indexation, the following section interprets Saeed's (who represents the UAE culture) cultural classification and establishes his interface requirements.

Power Distance: based on Hofstede's (1984) index, the UAE scores high (90) for this dimension (Figure 55), which means that UAE patients accept a hierarchical order in which everybody has a place and which needs no further justification. Hierarchy in an organisation is seen as reflecting inherent inequalities and centralisation; subordinates expect to be told what to do and the ideal boss is a benevolent autocrat.

Modelling implications: Saeed should be presented with a minimum set of sufficient navigation choices and minimal information. The interface should prevent errors, and provide limited functionality and links.

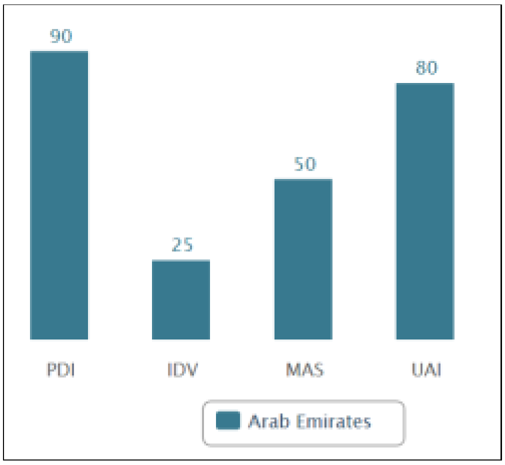


Figure 55: UAE Hofstede index

(Hofstede Centre, 2015)

Individualism: the UAE scores very low (25) in this dimension (Figure 55), which indicates that the UAE is more of a collectivistic society. This is manifested in a close long-term commitment to the member 'group', be that a family, extended family, or extended relationships. Loyalty in a collectivist culture is paramount, and over-rides most other societal rules and regulations. The society fosters strong relationships where everyone takes responsibility for fellow members of their group. In collectivist societies, offence leads to shame and loss of face, employer/employee relationships are perceived in moral terms (like a family link), hiring and promotion decisions take account of the employee’s in-group, and management is the management of groups.

Modelling implications: Saeed’s interface should display images of the UAE leaders and religious symbols.

Masculinity: the UAE is in the middle of the scale, as the score is 50, which classifies the UAE as a masculine society. This implies that people in the UAE are driven by competition, achievement and success, with success being defined by the winner and the best in the field, and the person in charge is expected to be decisive and assertive; the emphasis is on equity, competition and performance and conflicts are resolved by fighting them out.

Modelling implications: Saeed's interface should provide quick results, limited navigation choices, high-level executive views and be goal-orientation.

Uncertainty avoidance: the UAE scores high (80) on this dimension and thus has a high preference for avoiding uncertainty. This suggests that UAE people maintain rigid codes of belief and behaviour, and are intolerant of unorthodox behaviour and ideas. People have an inner urge to be busy and work hard, innovation may be resisted, and security is an important element in an individual's motivation.

Modelling implications: Saeed's interface should be modelled using Arabic language with familiar metaphors, simple articulation, simple navigation and limited information to reduce ambiguity.

As can be seen in Figure 56, Saeed's classification is mapped to the left end of the scale.

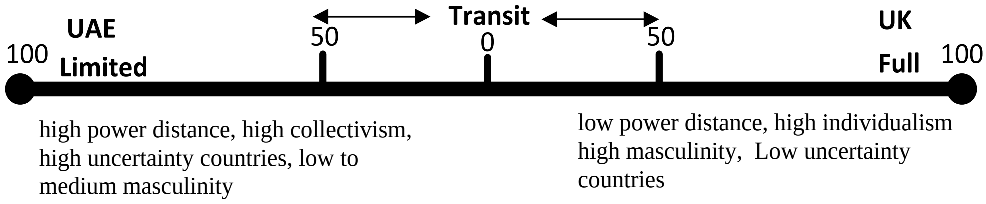


Figure 56: UAE and UK linear indices

The Adaptive Control observes Saeed's interaction, and then makes decisions on the suitable interface and contents he should have. As Saeed's initial classification is 'Limited', his profile can only be promoted to Transit, then to Full profile. The following section demonstrates the initial state of Saeed's interface and content, then shows how the Adaptive Control responds to Saeed's interaction behaviours, and how that impacts on both the interface and the contents.

Saeed's initial interface and contents provided by the Adaptive Control are shown in (Appendix B, Figure 82), where the language used is Arabic, an image of the leaders of UAE is presented, a Quranic phrase related to health is shown, the navigation links are kept to the minimum, and the symbol of the red crescent is shown.

Saeed clicks on the button that allows him to check if he is likely to be diabetic. i-Diagnose responds to the request by displaying all 'available' symptoms that are related to diabetes where Saeed is expected to select the symptoms from which he is suffering (Appendix B, Figure 83). Saeed's symptoms are compared against those stored in the knowledge base; the result is then displayed back to him. The result indicates that he is very likely to be diabetic. Rather than overwhelming Saeed with information that might confuse him, the Adaptive Control displays the appropriate feedback in a minimal way to adhere to his profile classification. The Adaptive Control also creates a container on the right hand side of the interface where Saeed's symptoms are displayed, which allows him to either delete a symptom by pressing the ⛔ icon or add a new symptom by pressing إضافة عارض صحي (add symptom).

As the diagnostic results indicated that Saeed is very likely to be diabetic, the Adaptive Control responds to this by adding a link to the navigation system to allow him to make an appointment with a doctor and allowing him to send a copy of his medical records to his email address (Figure 57).

The following section will illustrate how Saeed's interaction behaviour can promote his cultural classification from Limited to Transit, then to Full, and how that is likely to impact his interface and contents personalisation.

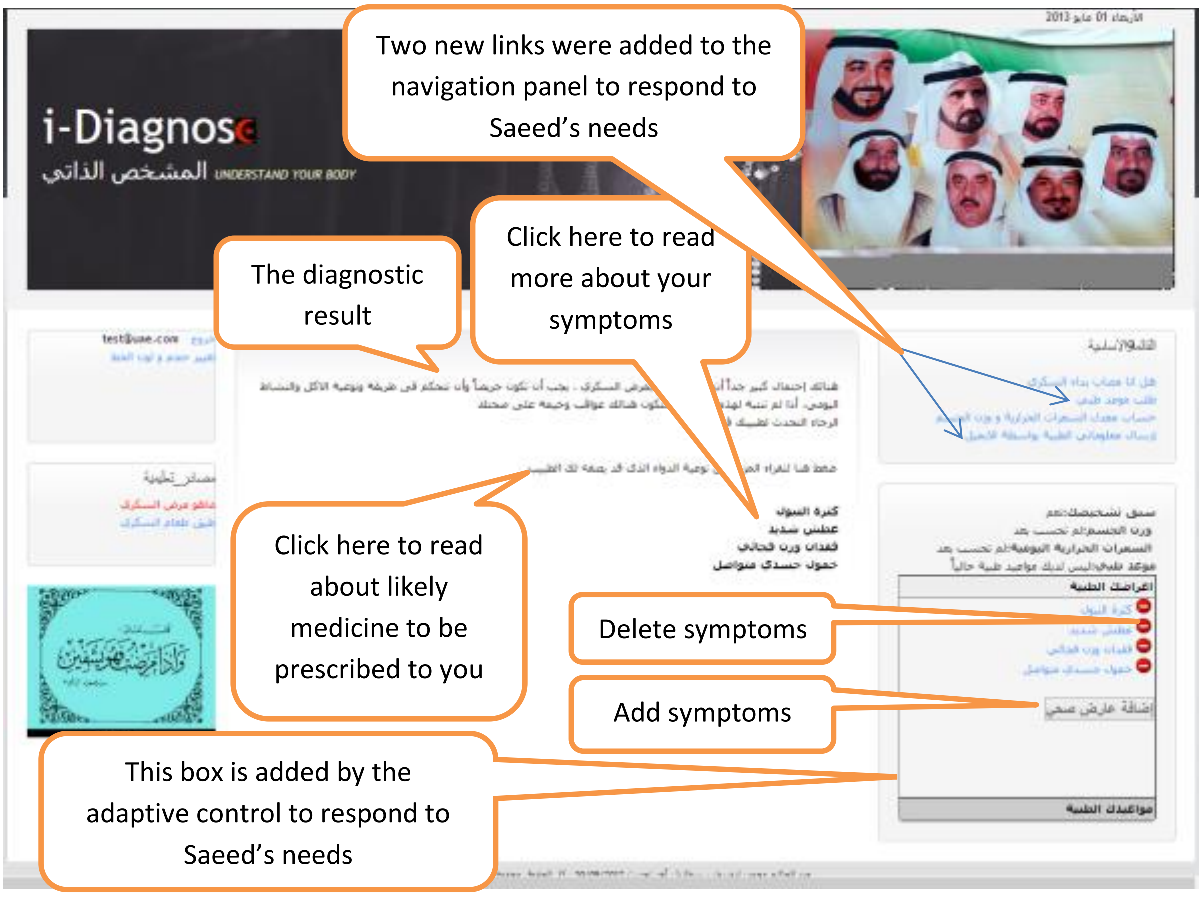


Figure 57: Extra interface elements made available to aid the patient session

Saeed’s diagnostic results returned four symptoms, as illustrated in Figure 84 (Appendix B), i-Diagnose responded to Saeed’s request by displaying more information about the symptoms from which he is suffering, which were acquired based on his profile, which indicates that he is ‘Limited’, and which in turn implies that the information he should receive should be kept to a minimum (Appendix B, Figure 85).

Saeed clicked on the readmore link requesting more information; i-Diagnose responded to the request by releasing the next level of the information related to the symptom (Appendix B, Figure 86). Saeed requested more information by clicking on readmore (Appendix B, Figure 86). Releasing the third level of the information indicates that Saeed is likely to read more than the average person in his culture, so i-Diagnose responds to this by promoting Saeed’s profile to Transit.

i-Diagnose responds to Saeed’s Transit state by caching the new two elements into the interface, as illustrated in Figure 87.

If Saeed wants to read more about one of his other symptoms, he then repeats the above steps by clicking on readmore. At this stage, Saeed’s profile will be promoted to ‘Full’ as he completed (readmore, readmore, Transit, readmore, readmore, Full). Figure 58 shows the new elements made available to Saeed to reflect his ‘Full’ profile access rights. If Saeed traverses back by clicking on ‘Hide’, i-Diagnose will recursively hide the elements of the interface and limit the contents based on his profile classification.

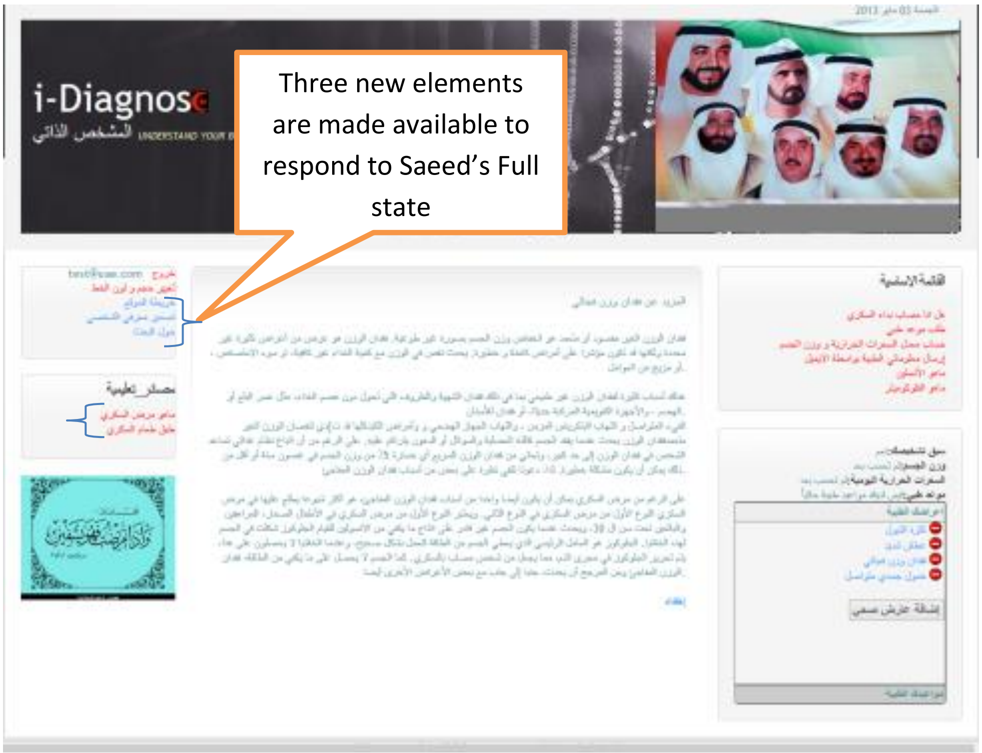


Figure 58: Typical Arabic 'Full' state profile interface

From the other end, John is a British citizen who also accessed i-Diagnose to check his symptoms. British culture is more towards the other end of the scale (Figure 56) compared to the UAE, as, according to Hofstede (1984), the UK is classified as a low power distance, high individualism, masculine and low uncertainty avoidance culture, as illustrated in Figure 59.

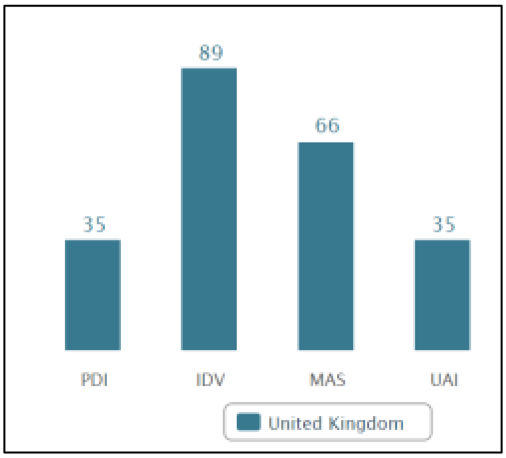


Figure 59: UK Hofstede index

Based on e-HTAM (Chapter 3) findings, UK cultural modelling could be as follows:

- **Low Power distance** modelled through freedom of navigation, high access to information, informative presentation, and emphasis on patients (not leaders or organisations). Power distance dimension is mapped into interface design as navigation, contents, functionality, symbols, errors and links.

  Modelling implications: John should be presented with unlimited navigation choices, maximum information. The interface should have its full functionality and links.

- **Individualism** features an emphasis on the patients and their goals, and possible actions they can carry out using the website. The Individualism/Collectivism dimension is mapped into interface design as imagery, colour and language.

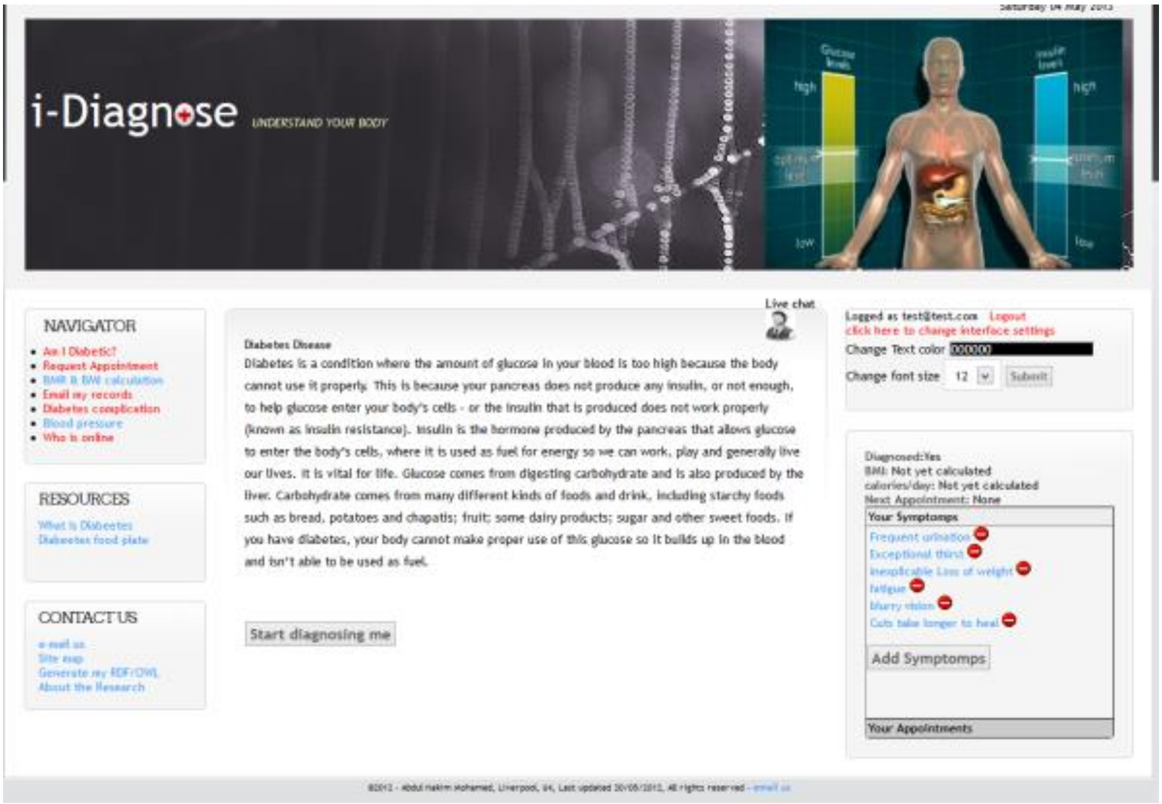
  Modelling implications: John's interface should display images and symbols that reflect the patient's interests rather than the organisation's interests.

- **Masculine** can be modelled by quick results, unlimited navigation choices, high-level executive views, goal and work-orientation. The masculine dimension is mapped into interface design as aesthetics, unifying values used to gain attention and appeal.

  Modelling implications: John's interface should provide sufficient and informative results, and full navigation choices.
- **Low Uncertainty Avoidance** is represented by complexity of contents and navigation choices, pop-up windows, multiple types of interface controls, 'hidden' content that must be displayed by scrolling. Uncertainty Avoidance is mapped into interface design as communication, colour and navigation.

  Modelling implications: John's interface should have many links, pop-ups, and a complex interface that uses satisfactory colours.

Based on the above, John's profile classified as 'Full' where every possible feature of the system is made visible to him, as illustrated in Figure 60.



Diabetes Disease

Diabetes is a condition where the amount of glucose in your blood is too high because the body cannot use it properly. This is because your pancreas does not produce any insulin, or not enough, to help glucose enter your body's cells - or the insulin that is produced does not work properly (known as insulin resistance). Insulin is the hormone produced by the pancreas that allows glucose to enter the body's cells, where it is used as fuel for energy so we can work, play and generally live our lives. It is vital for life. Glucose comes from digesting carbohydrate and is also produced by the liver. Carbohydrate comes from many different kinds of foods and drink, including starchy foods such as bread, potatoes and chapatis; fruit; some dairy products; sugar and other sweet foods. If you have diabetes, your body cannot make proper use of this glucose so it builds up in the blood and isn't able to be used as fuel.

Logged as test@test.com

Change Text color 000000

Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: Not yet calculated
Next Appointment: None

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Figure 60: Typical English ‘Full’ state profile interface

If John followed Saeed’s promotion steps recursively he will end up with ‘Limited’ English interface, as illustrated in Appendix B, Figure 88, while his state in ‘Transit’ is illustrated in Appendix B, Figure 89.

Other conditional features are made available based on the patient interaction, such as making appointments, and checking BMI and BMR, and sending the medical records to the patient’s email box. The following section illustrates how those features are accessed.

The booking appointment feature is only made visible if the profile classification is ‘Full’ or the patient has been diagnosed with positive symptoms. As illustrated in Appendix B, Figure 90, when the patient clicks on request appointment, i-Diagnose displays the calendar where the patient is expected to select a date, give a reason for requesting an appointment and select the gender of the treating doctor. Patient appointments are deleted by clicking on ⊖, which invokes the PHP code illustrated in pseudocode 4 (Appendix A)

To receive a copy of their medical records, the patients should be diagnosed with positive symptoms, as illustrated in Appendix B (Figure 91), while BMR and BMI calculation is illustrated in Appendix B (Figure 92), where measures and weight are presented in a way that the patients can understand. Pseudocode 5 (Appendix A) lists the PHP code used to calculate BMR and BMI.

Symptoms are also deleted by clicking on ⛔, which invokes the PHP code illustrated in pseudocode 6 (Appendix A), while pseudocode7 (Appendix A) illustrates the PHP code that is used to gather and email patient health records.

Figure 61 graphically represents diabetes as an ontology and shows the state of the information patients should receive at level 1, level 2 and level 3. The patient navigation from level to level is dictated by the adaptive control; the more the patients read, the more their profile access rights are increased. The algorithm for contents and interface personalisation is illustrated in Figure 62, which is in line with PCCeDA’s personalisation process.

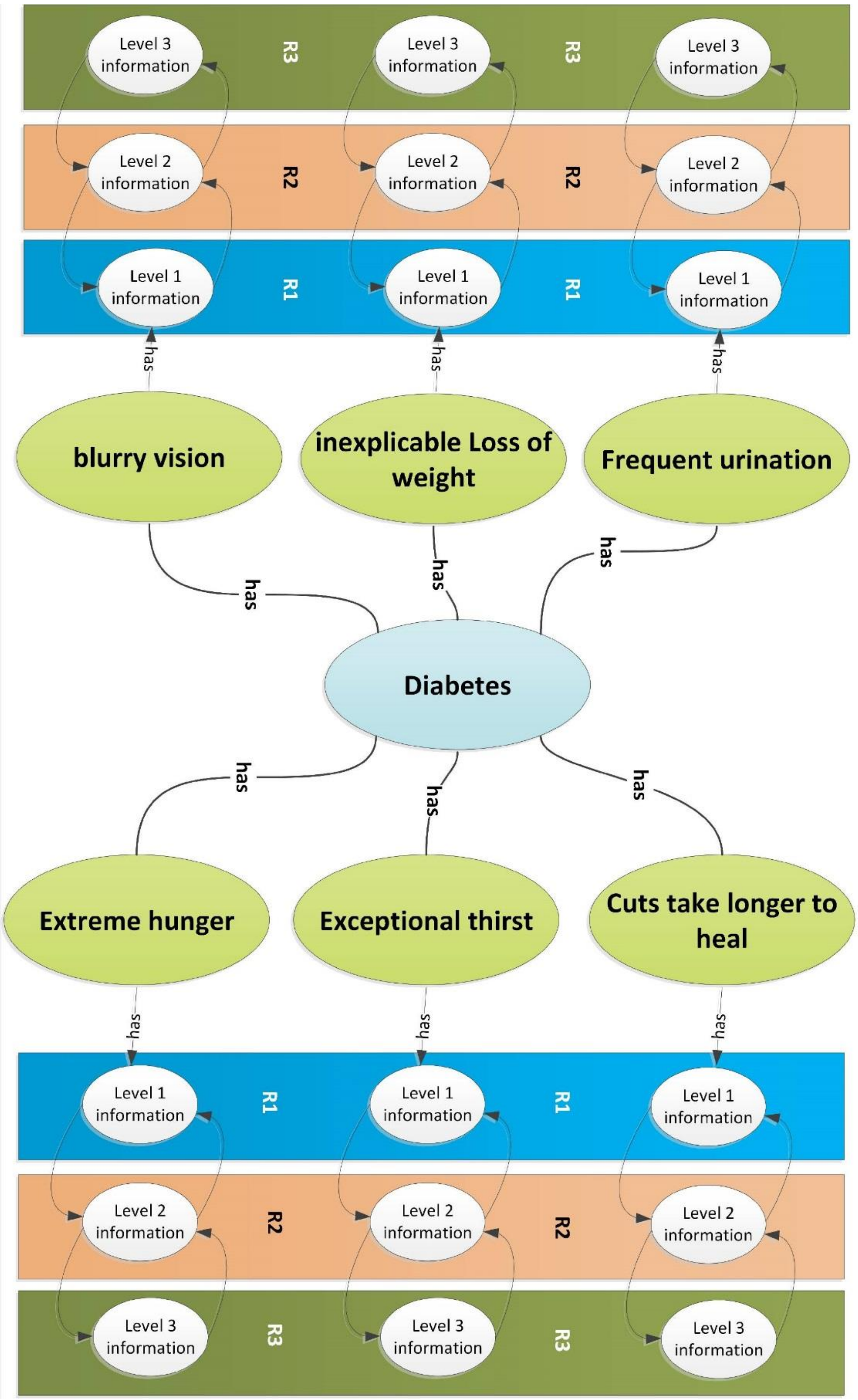


Figure 61: Possible symptom navigation path

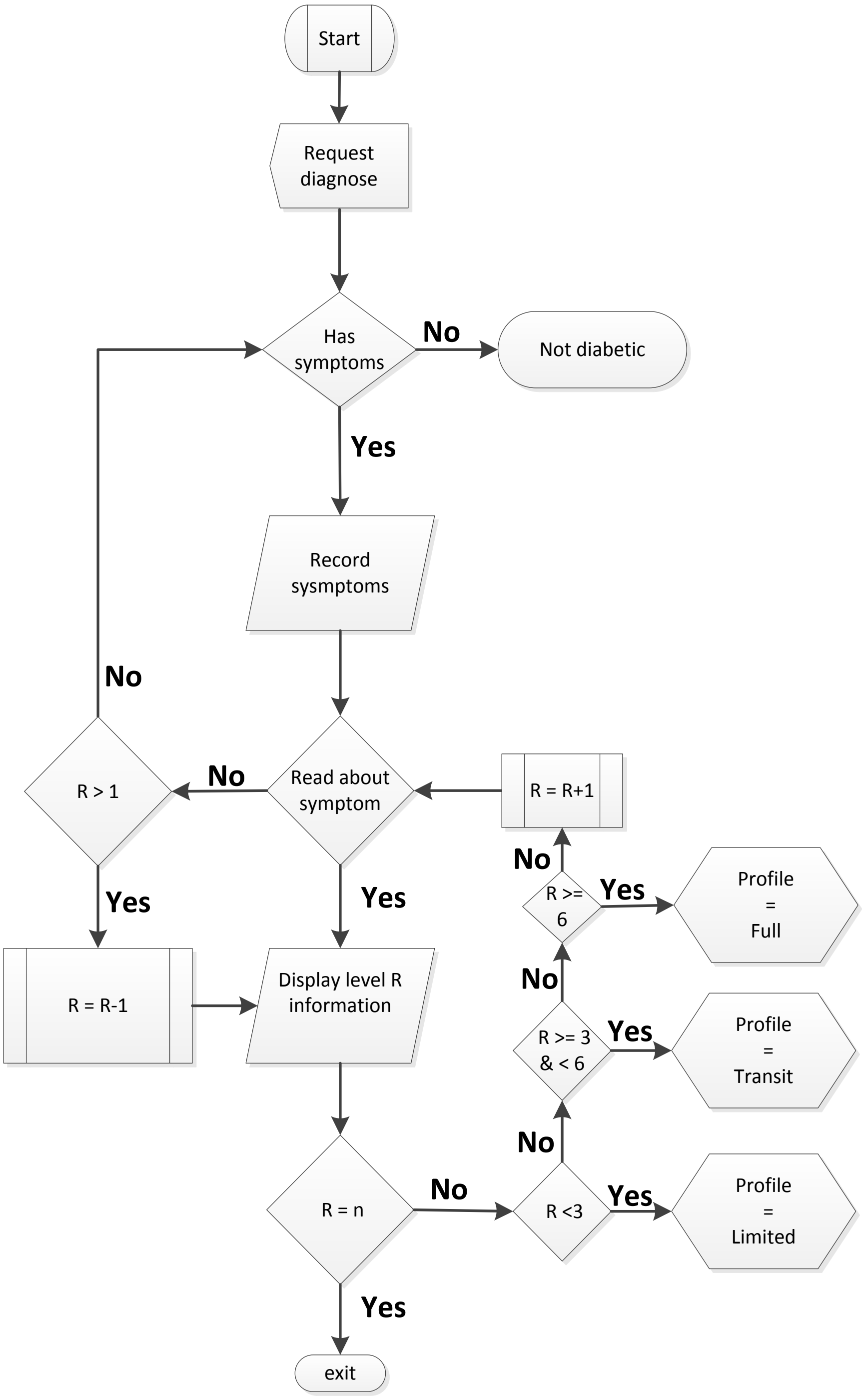


Figure 62: i-Diagnose adaptation algorithm

Error prevention and support during the patient interaction session

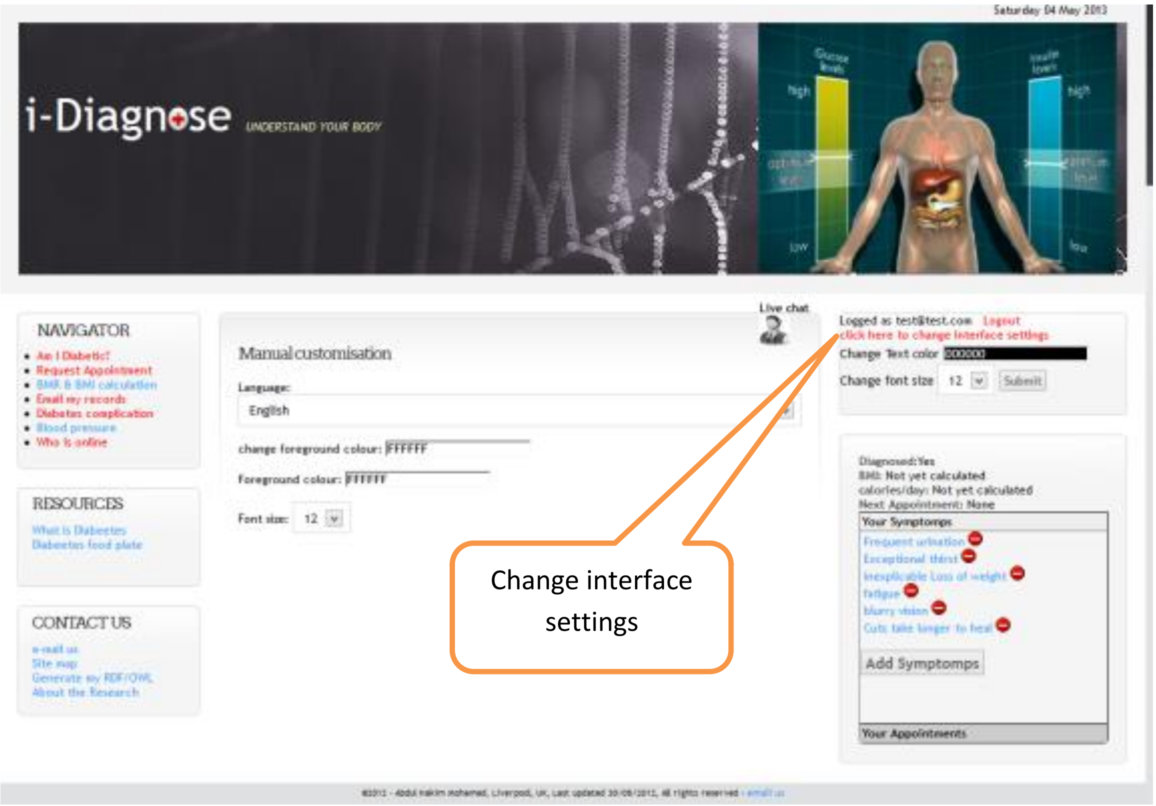
i-Diagnose supports the patient during her/his interaction session and ensures that it is an error-free session; this is achieved by many measures put in place to deal with any unexpected errors either during the runtime or as a result of patient 'uncharacterised/unsupported' interaction behaviours. The following section illustrates some of those measures and their primary purpose.

i-Diagnose is a cross-platform development; however, the patient device environment setting can sometimes force PHP to return some errors that are not associated directly with i-Diagnose but rather to the device setting. To deal with such uncontrollable situations, a PHP error_reporting(0) function was included in the i-Diagnose header, which prevents any error message that is not within the i-Diagnose boundary from being displayed on the screen. During the interaction, if for an unexpected reason an exception is generated by the server, a function that is included in the header processor catches the exception and allows the patients to continue with their tasks (Appendix A, pseudocode 8).

Validation rules are applied to control values that are expected to be provided by the patient. JavaScript function was developed and included in the header section to validate the patients' entries (Appendix A, pseudocode 9).

4.4.5. Manual Customisation

i-Diagnose allows the patients to manually customise some elements of the system to better suit them, which is very likely to improve the interface aesthetics based on the patient's preference. If the patients perceive the interface face as aesthetic, it is very likely that they will enjoy using it. i-Diagnose allows the patients to change the interface language, fonts, font size, foreground and background colours, as illustrated in Figure 63.



Manual customisation

Language: English

change foreground colour: FFFFFF

Foreground colour: FFFFFF

Font size: 12

Logged as test@test.com

Change Text color 000000

Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: Not yet calculated
Next Appointment: None

Frequent urination
Exceptional thirst
inexplicable Loss of weight
fatigue
blurry vision
Cuts take longer to heal

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Change interface settings

Figure 63: Interface manual customisation

4.4.6. Summary

Patient modelling offers a broader understanding of the patient's interaction with technologies in the real world. This chapter has presented PCCeDA as a framework that can be used to develop patient-centred, culturally-aware systems. The chapter started by reviewing relevant work in the field of adaptive systems, followed by an approach to the patient-centeredness design in a cultural context.

The PCCeDA framework consists of a patient model, gatekeeper, Adaptive Control and knowledge base which consist of medical and cultural repositories. The personalisation of both interface and contents has also been discussed.

This chapter has also demonstrated how PCCeDA can be used to develop a patient centred-culturally-aware e-Health web-based service. PCCeDA was used to develop i-Diagnose, which consists of a patient model, adaptive control and a knowledge base. The primary functionality of i-Diagnose is that it is patient-centred and culturally adaptive in nature.

i-Diagnose is a web-based patient-centred Culturally-aware e-Health system for people who may be experiencing diabetic symptoms. It allows the patients to check if they are likely to be diabetic, book appointments and check their BMI and BMR, and also allows them to have their health records emailed to them.

i-Diagnose, which is the proof of concept of our research, is informed by the findings of e-HTAM (chapter 3) and the literature review in chapter 2. The main objective of i-Diagnose is to investigate and assess the effectiveness and usefulness of integrating culture into a technology acceptance model, and how that integration would make the e-Health web-based services acceptable across various cultural settings. While i-Diagnose specification articulates the requirements to fully integrate measurable cultural variables and technology design factors, it is important to clarify that only key functional features and data models are implemented as a proof of concept.

In order to make the patient profile accessible by other online applications, the patient instance can be exported as OWL, RDF or XML for other systems to consume, which will make the patient profile a portable object where it can be applied to newly accessed/developed systems, which will enable those systems to adapt their environment to suit the patient.

When the patient initially accesses i-Diagnose, her/his main cultural markers are captured by i-Diagnose to create an initial profile that describes the patient, and whether this initial profile is classified as Limited, Transit or Full. Based on the profile classification, i-Diagnose Adaptive Control personalises the interface and the contents to suit the patient. The Adaptive Control works in the background to observe the patient’s interaction behaviour and react accordingly. Based on the patient interaction, the agent can promote the patient profile from ‘Limited’ to ‘Full’ via ‘Transit’ or vice versa.

The next chapter will discuss the evaluation of the developed prototype and assess the effectiveness of the patient-centred, culturally-aware design approach and its implications for e-Health web-based services acceptability and adoption.

Chapter 5: Prototype Evaluation

5.1. Introduction

In this chapter, we report on the evaluation study carried out to test the ability of the i-Diagnose prototype (based on the PCCeDA framework) to adapt adequately to a patient's cultural background. The purpose of this study is to determine the effect a patient-centred culturally-aware design approach can have on e-Health adoption (Mohamed et al., 2013). The problem motivating this study is that people from different cultures need to be able to benefit from health services available via the Internet; however, the current e-Health design approach does not take into consideration various cultural contexts to which a system could be exposed, which affects its overall acceptance and adoptions.

i-Diagnose is a prototype that is designed to assess the contribution that a patient-centred, culturally-aware design approach can make to the field of e-Health information systems design. To better assess the significance of the inclusion of the cultural factors, i-Diagnose needs to be compared to a system that is not equipped with culturally sensitive features. Therefore, to better assess i-Diagnose, a similar standard interface was designed that is not culturally-aware or personalise-able; it is called the Non-patient-centred i-Diagnose (NPCI), while the i-Diagnose version that is based on PCCeDA is called the PCI. As the PCI has been discussed in the previous chapter, the following section describes the NPCI.

The NPCI lacks personalisation features; however, all the information available through the PCI is made available as static 'non-customisable' contents in the NPCI, so the patients will need to read through it and make their own decisions. Figures 93 and 94 (Appendix B) illustrate the English version of the NPCI, while Figures 95 and 96 (Appendix B) illustrate the Arabic version of it.

5.2. Methodology

Building on the philosophy presented in chapter three, the next sections will discuss the sample, demographics, questionnaires, reliability and the statistical methods adopted to analyse the data collected to evaluate the i-Diagnose interface.

5.2.1. The sample

The respondents' demographic information (gender and country of origin) is summarised in table 3. Based on opportunity sampling methods, two groups from the UK and two groups from the UAE were invited to participate in the experiment; each group consisted of 200 participants. One group from the UK and one group from the UAE experimented with i-Diagnose PCI, while the other group from the UK and the other group from the UAE experimented with i-Diagnose NPCI. The data was collected through the i-Diagnose interface. As can be seen in the case processing (table 3), the UAE female participants reported the smallest return value; hence, a decision was made to take that as a basis to define the size of groups in order to have a representative and homogenous sample. The data was filtered, and 276 samples from each country were selected, of which each gender type represents 50% of the sample.

Table 3: Case processing summary

i-Diagnose version		Male		Female		Total	**Selected**		Total selected for analysis
		Total	Valid	Total	Valid		**Male**	**Female**	
PCI i-Diagnose	UAE	100	85	100	79	164	**69**	**69**	138
	UK	100	93	100	84	177	**69**	**69**	138
NPCI i-Diagnose	UAE	100	71	100	**69**	140	**69**	**69**	138
	UK	100	82	100	73	155	**69**	**69**	138

Three main locations were chosen to conduct the survey, namely Liverpool in the UK and Dubai and Alain in the UAE. These sites were chosen due to logistic/cost reasons and they represent the culture of each country.

5.2.2. The Questionnaire

The questionnaire used to collect the opinions of the respondents is shown in the Appendix C. The following is a summary of the items assessed and details of the corresponding statements to which the responses were sought.

Power Distance was measured through the following statements:

- The i-Diagnose navigation system is adequate and suitable for me.
- The information provided by i-Diagnose is adequate and suitable for me.

Masculinity was measured through the following statement:

- The i-Diagnose interface is appropriate for me, as I can control and explore it easily.

Uncertainty Avoidance was measured through the following statement:

- I'm not worried about making mistakes while interacting with i-Diagnose

Individualism/Collectivism was measured through the following statements:

- I will ask my friends for help if I have any issues while using i-Diagnose.
- I would be willing to share my appointments and health records with my friends and family.

Tangibility was measured through the following statements:

- i-Diagnose self-diagnostic features helped me form a positive attitude towards online health services.
- i-Diagnose can be a relatively acceptable alternative to speaking with a doctor face to face to check my symptoms.

Trust was measured through the following statement:

- i-Diagnose is safe and I do not fear that my personal data may be stolen or misused.

Subjective norms were measured through the following statement:

- People who influence my behaviour think that I should use e-Health web-based services.

Perceived Ease of Use was measured through the following statement:

- I can easily diagnose myself through i-Diagnose

Perceived Usefulness was measured through the following statements:

- Information provided by i-Diagnose is useful
- i-Diagnose helped me understand more about diabetes.

Intention to Use e-Health was measured through the following statement:

- I intend to use i-Diagnose (or similar online tools) to check my symptoms or book an appointment.

Personalisation was measured through the following statement:

- i-Diagnose knows who I am, and provides a tailored screen to suit me

Interactivity was measured through the following statement:

- i-Diagnose interactivity features were useful.

Accuracy was measured through the following statement:

- i-Diagnose provides an explanation whenever I can’t access elements in the interface.

Responsiveness was measured through the following statement:

- When I click on an option i-Diagnose returns the result quickly (the response rate is acceptable).

5.2.3. Statistical Methods

The statistical methods used in the next sections builds on the statistical definitions and techniques discussed in chapter three (section 3.7).

According to Tabachnick et al. (2007), reliability coefficient is defined as the presence of variance in an observed variable that is accounted for by true scores on the underlying construct. e Internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total. Pallant (2010) indicated that the index used to measure internal consistency reliability is the Cronbach alpha coefficient.

Cronbach's α is used as an estimate of the reliability of a psychometric test. It estimates to what extent the items measure the same underlying concept. It can be defined as

$$\alpha = \frac{K\bar{c}}{(\bar{v} + (K-1)\bar{c})}$$

where there are K items, $\bar{v}$ is the average variance of each component (item), and $\bar{c}$ is the average of all covariance between the components across the current sample of persons (that is, without including the variances of each component).

This coefficient of reliability ranges from 0 to 1, with an accepted cut-off point of 0.7 (Pallant, 2010). Before administering principal component analysis, the coefficient alpha was computed to determine the internal consistency and reliability of the scale used in these research questions.

The nature and the size of the data suggests the use of t-tests for two independent samples to confirm whether there is a statistically significant difference in the mean scores for the two groups. The p-value quoted is the probability of observing a difference between the two samples at least as large as that observed in the sample if the two sets of scores had come from the same population. In order to do this, the independent-samples t-test was employed to compare the mean score of sociocultural and technology design factors for both the UK and the UAE.

According to Pallant (2010), t-test effect size statistics provide an indication of the magnitude of the differences between groups (not just whether the differences could have occurred by chance). There are a number of different effect size statistics, the most commonly used being η^2 (Eta squared: the proportion of the total variance that is attributed to an effect), which can range from 0 to 1, and which represents the proportion of variance in the response variable that is explained by the explanatory variable. The procedure for calculating η^2 for i-Diagnose actual use is:

$$\eta^2 = \frac{t^2}{t^2 + (n1 + n2 - 2)}$$

where t is the statistic from the t test, n1 and n2 are the numbers of subjects in the samples being compared.

Cohen’s (1988) guidelines for effect interpretation are that the effect is small if it equals 0.01, moderate if it equals 0.06, and large if it equals 0.14.

To assess and validate the patients’ satisfaction, the absolute satisfaction factor was calculated to measures the variance between PCI and NPCI effects on the participants. The satisfaction factor will be referred to as s1 for UK and UAE, which will be calculated as = $\frac{\text{UK mean} - \text{UAE mean}}{\text{max scale points}}$, where the maximum scale point is 5 (based on the Likert scale used in this study).

The UK s1 and the UAE s1 mean will be calculate as PCI overall ‘average’ satisfaction rate (*pSat*) for PCI.

5.2.4. Reliability of the Survey Items

Cronbach’s α was calculated for the 15 items, based on a sample of 552 subjects, as α = 0.950. This confirms that there was good agreement between different items.

5.3. Data analysis, results and Hypothesis discussion

This section discusses the results obtained from the sampled population. Experiments were carried out with the patient-centred culturally aware version of i-Diagnose (PCI) and the non-culturally aware standard version of i-Diagnose (NPCI). Sociocultural factors are discussed, which consist of Power Distance (PD), Individualism/Collectivism (IND), Uncertainty Avoidance (UA), Masculinity (MAS), Trust, Tangibility and Subjective Norm (SN). Technology acceptance factors and e-Health technology design factors are also examined. A further test looks at the overall use of the system called Actual System Use (ASU).

5.3.1. Cultural Factors [H1]

Power Distance (PD)

PD is represented by the freedom of navigation and information; rather than asking the participants direct questions about PD, the PD dimension was coded into the i-Diagnose interface, and then the participants were asked to assess the significance of the PD elements of the interface.

PD was measured by the following statements (averaged responses):

- The i-Diagnose navigation system is adequate and suitable for me.
- The information provided by i-Diagnose is adequate and suitable for me.

The majority of the participants who used the PCI indicated that the navigation system and the content provided by i-Diagnose is suitable for them. In the previous stage of this research, PD was reported to have a weaker correlation with I2U (chapter 3), which was merely due to the static nature of the initial tested system.

The UK PD statistics (M=4.26, SD=0.70) for PCI patients and for NPCI (M=1.04, SD=0.19), while for the UAE (M=4.28, SD=0.68) for PCI and (M=1.54, SD=0.95) for NPCI, which suggests that the PCI’s supportive environment reduced the negative effect of PD amongst the sampled population. The histogram (Figure 64) illustrates the collective (UK and UAE) data distribution of PD.

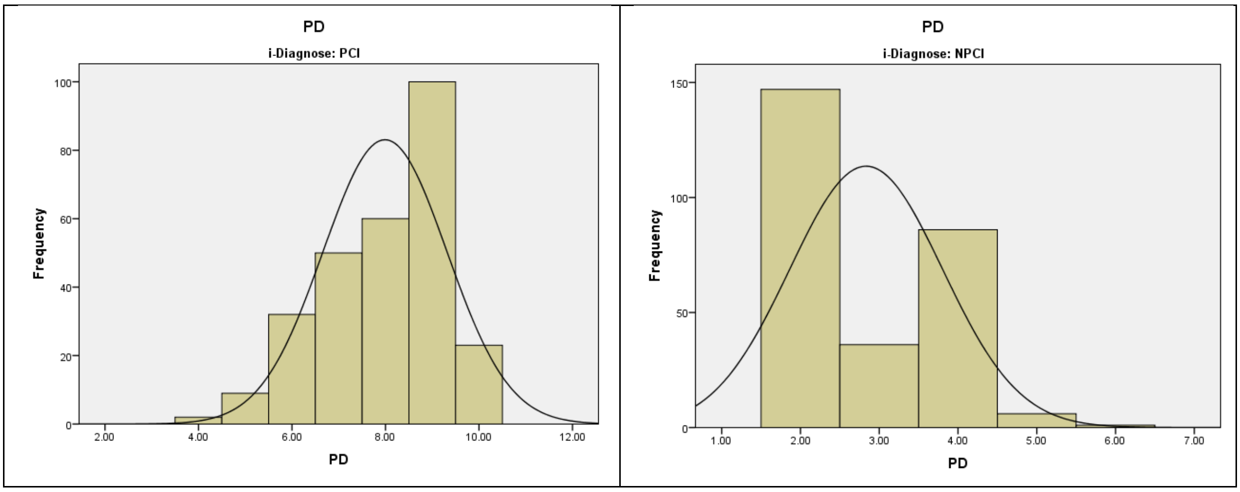

Figure 64: Distribution of Power Distance Responses

The findings showed that PD is significantly negatively correlated with ASU (*r* = -0.892 p < 0.0001). The independent-samples t-test was conducted to compare the influence of PD on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M=4.27, SD=0.69) and NPCI (M = 1.29, SD = 0.57); t = 59.83 (df = 550), p < 0.0001.

The PD *pSat* indicated that the PCI PD interface design approach enhanced the patient’s satisfaction by 60% (table 4), which was further supported by η^2 = 0.87.

The PD statistics above suggest that both the UAE and the UK PCI participants acknowledged that the i-Diagnose navigation system is suitable for them, as it provides them with an adequate level of information. The UK NPCI statistics (table 4) indicated a degree of dissatisfaction in terms of the navigation-ability and the density of information of the NPCI, as it provides the patients with limited navigation options and minimal information.

The i-Diagnose design approach demonstrated that the negative effect of a high PD can be reduced through the appropriate inclusion of adaptive systems that are culturally-aware. Such inclusion will enable the tailoring of the contents and the navigation system in a way that suits individual patients, and only shows sufficient amount of information based on the patient's cultural profile, which is one contribution that i-Diagnose makes to the field of cross-cultural e-Health systems design.

Table 4**:** PCI vs NPCI Statistics

Variable	UK PCI M (n=138)	UK PCI SD	UK NPCI M (n=138)	UK NPCI SD	UAE PCI M (n=138)	UAE PCI SD	UAE NPCI M (n=138)	UAE NPCI SD	UK *s1 (UK PCI M-UKNPCI M)/5*	UAE *s1 (UAE PCI M-UAE NPCI M)/5*	t df(550)	Sig.	η^2	PCI M (UK+UAE)/2 n=276	PCI Std. Dev	NPCI M (UK+UAE)/2 n=276	NPCI Std. Dev	*pSat* (UK s1+UAE s1)/2	r with ASU
ASU	4.50	0.31	2.13	0.58	4.46	0.28	2.24	0.33	0.47	0.44	67.87	0.0001	0.89	4.48	0.29	2.19	0.46	0.46	--
PU	4.45	0.53	2.32	0.78	4.48	0.51	2.41	0.49	0.43	0.41	41.52	0.0001	0.76	4.47	0.52	2.37	0.64	0.42	.899**
PEOU	3.99	0.90	1.92	0.77	4.12	0.38	1.80	0.40	0.41	0.46	39.24	0.0001	0.74	4.06	0.64	1.86	0.59	0.44	.795**
I2U	4.52	0.78	1.71	0.75	4.11	0.32	1.66	0.48	0.56	0.49	40.89	0.0001	0.75	4.32	0.55	1.69	0.62	0.53	.884**
PRSN	4.14	0.69	1.89	0.31	4.48	0.53	1.72	0.45	0.45	0.55	55.57	0.0001	0.85	4.31	0.61	1.81	0.38	0.50	.869**
RSPN	4.23	0.79	2.10	0.79	4.40	0.55	2.05	0.70	0.43	0.47	36.80	0.0001	0.71	4.32	0.67	2.08	0.75	0.45	.817**
ACC	4.34	0.57	2.73	1.28	4.38	0.54	1.99	0.68	0.32	0.48	27.23	0.0001	0.57	4.36	0.56	2.36	0.98	0.40	.762**
INTR	4.51	0.25	2.02	0.56	4.46	0.24	2.30	0.29	0.50	0.43	31.32	0.0001	0.64	4.49	0.25	2.16	0.43	0.47	.733**
MAS	4.18	0.79	1.86	0.74	4.01	0.79	2.39	0.86	0.46	0.32	28.35	0.0001	0.59	4.10	0.79	2.13	0.80	0.39	-.792**
PD	4.26	0.70	1.04	0.19	4.28	0.68	1.54	0.95	0.64	0.55	59.83	0.0001	0.87	4.27	0.69	1.29	0.57	0.60	-.892**
UA	4.17	1.04	1.54	0.61	3.45	1.06	2.05	0.37	0.53	0.28	26.96	0.0001	0.57	3.81	1.05	1.80	0.49	0.40	-.734**
IND	2.92	1.09	2.08	0.62	3.38	0.92	2.01	0.49	0.17	0.27	16.35	0.0001	0.33	3.15	1.01	2.05	0.56	0.22	.564**
TANG	4.01	0.88	1.93	0.78	4.09	0.29	1.89	0.62	0.42	0.44	40.15	0.0001	0.75	4.05	0.59	1.91	0.70	0.43	.899**
Trust	3.95	0.85	2.06	0.84	3.78	0.60	2.13	0.69	0.38	0.33	27.56	0.0001	0.58	3.87	0.73	2.10	0.77	0.35	.803**
SN	4.01	0.86	1.94	0.79	4.09	0.29	1.89	0.31	0.41	0.44	40.33	0.0001	0.75	4.05	0.58	1.92	0.55	0.43	.837**

Masculinity (MAS)

Masculine cultures are more technically focused, with an interest in technology and website usage to perform tasks and enhance their achievements. In contrast, feminine cultures are concerned with people and the role of technology to support this orientation (Marcus, 2002).

MAS was measured by the following statement:

- The i-Diagnose interface is appropriate for me, as I can control and explore it easily.

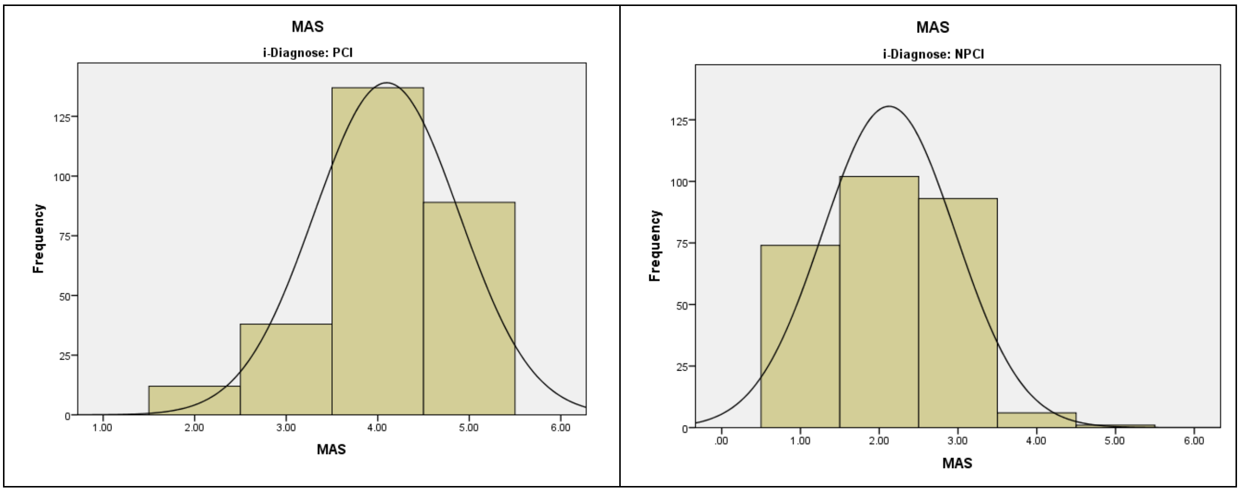

Figure 65: Distribution of Masculinity Responses

The UK MAS statistics (M= 4.18, SD= 0.79) for PCI patients and for NPCI (M=1.86, SD=0.74), while for The UAE (M=4.01, SD=0.79) for PCI and (M=2.39, SD=0.86) for NPCI. The histogram (Figure 65) illustrates the collective (UK and UAE) data distribution of MAS.

MAS is significantly negatively correlated to the Actual i-Diagnose System Use (ASU) (r = -0.792, p < 0.0001). This may suggest more masculine-orientated patients would be less inclined to use the i-Diagnose and that the current sample may have a more feminine orientation.

The independent-samples t-test was conducted to compare the influence of MAS on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.10, SD = 0.79) and NPCI (M = 2.13, SD = 0.80); t = 28.35 (df = 550), p < 0.0001.

The MAS *pSat* indicated that PCI MAS interface elements enhanced patient satisfaction by 39% (table 4), which was further supported by η^2 = 0.59, indicating a large difference in the magnitude between the PCI and NPCI effect.

It was expected that the mean for Masculinity would be lower for the UAE compared to the UK sample (Hofstede 1984, 2001; Marcus, 2000). This was found to be somewhat true overall, however, the results are specific to the interface and levels of masculinity exhibited in the responses are different depending on which interface is used. Overall, there is a tendency for the UAE participants to exhibit more masculinity on the NPCI interface while the UK participants indicated more femininity on the PCI interface (saying it was easier to use than the UAE participants did).

The PCI patients' data indicated that the majority of patients felt that the interface was appropriate for them, as they can explore the various interface sections without difficulties, while the NPCI data indicated a general dissatisfaction amongst the patients.

These results suggest that there is an indication of feminine orientation amongst the UK and UAE samples. The PCI personalisation capability resolved the conflict that MAS can cause by initially fetching the most appropriate data that suits the patients, while allowing them to manually adjust the system settings.

Uncertainty Avoidance (UA)

UA was measured by the following statement:

- I'm not worried about making mistakes while interacting with i-Diagnose

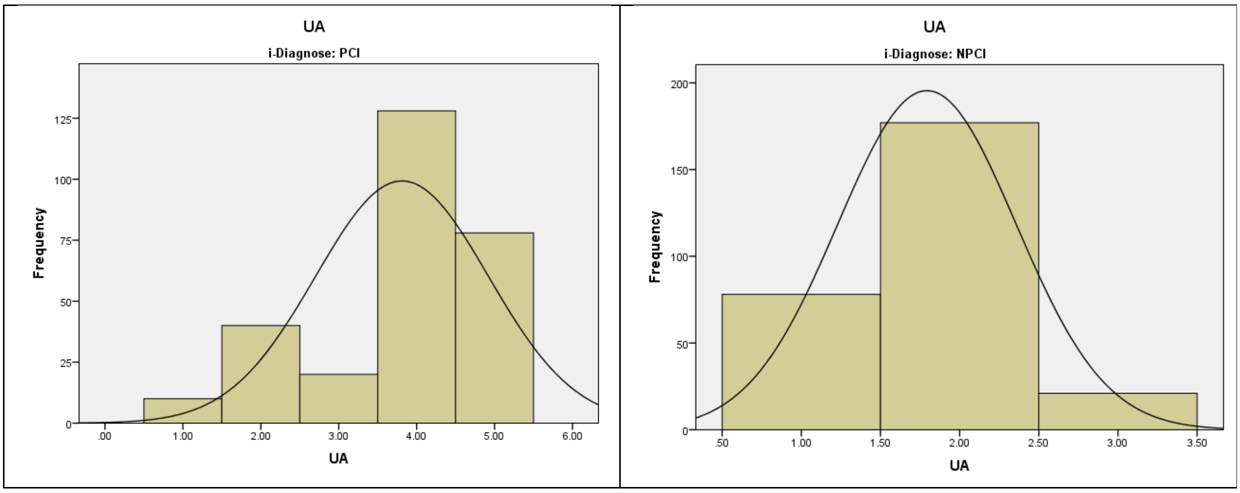

Figure 66: Distribution of Uncertainty Avoidance Responses

Unlike the case of the UAE PCI, the UK PCI instance provides UK patients with a complex interface that has the maximum possible contents; navigation and choices are available to the system; hidden contents and pop-up menus will be visible according to the level of the information accessed.

The UK UA statistics were (M=4.17, SD=1.04) for PCI patients and for NPCI (M=1.54, SD=0.61), while for the UAE (M=3.45, SD=1.06) for PCI and for NPCI (M=2.05, SD=0.37), which suggests that the PCI's supportive environment reduced the negative effect of uncertainties amongst the sampled population. The histogram (Figure 66) illustrates the collective (UK and UAE) data distribution of UA.

These findings showed that UA is significantly negatively correlated to actual i-Diagnose system use ($r = -0.734$, $p < 0.0001$. An independent-samples t-test was conducted to compare the influence of UA on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 3.81, SD= 1.05) and NPCI (M = 1.80, SD = 0.49); $t = 26.96$ (df = 550), $p < 0.0001$.

The UA *pSat* indicated that PCI UA interface design approach enhanced the patient's satisfaction by 40% (table 4), which was further supported by $\eta^2 = 0.57$.

These statistics above suggest that UA is likely to have a culturally specific impact on e-Health services' acceptance. Higher levels of UA are present on the NPCI interface for the UAE users compared to the UK users while this pattern is reversed for PCI.

These results suggest that, through a culturally-aware and patient-centred interface, the negative effect of UA can be reduced, and converted into a positive measure that can increase the patient's perception of e-Health benefits. Decreasing the level of uncertainty in an interface increases the level of satisfaction, which will impact relatively positively on the patient's acceptance of e-Health web services.

Individualism/Collectivism (IND)

IND was measured by the following statement (averaged responses):

- I will ask my friends for help if I have any issues while using i-Diagnose.

- I would be willing to share my appointments and health records with my friends and family.

The UK IND statistics (M=2.92, SD=1.09) for PCI patients and for NPCI (M=2.08, SD=0.62), while for the UAE (M=3.38, SD=0.92) for PCI and for NPCI (M=2.01, SD=0.09). The histogram (Figure 67) illustrates the collective (UK and UAE) data distribution of IND.

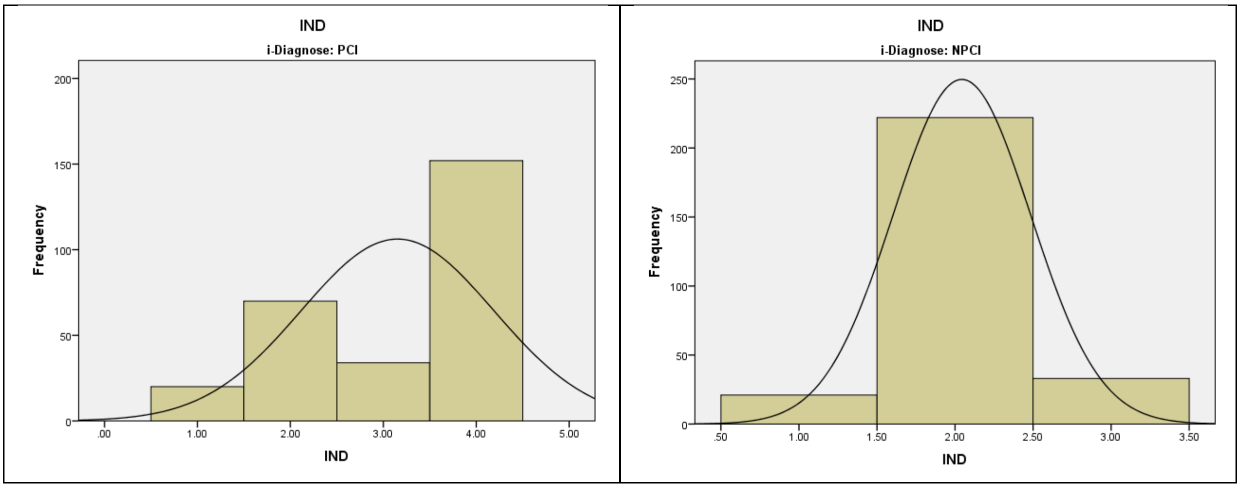

Figure 67: Distribution of Individualism/Collectivism Responses

IND significantly negatively correlated with ASU (*r*=-0.564, *p* < 0.0001). An independent-samples t-test was conducted to compare the influence of IND on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 3.15, SD= 1.01) and NPCI (M = 2.05, SD = 0.56); t = 16.35 (df = 550), p < 0.0001. This would suggest that patients with higher levels of individuality would be less likely to use e-Health systems.

The IND *pSat* indicated that PCI IND interface design approach enhanced the patient's satisfaction by 22% (table 4), which was further supported by η^2 = 0.33.

The PCI support the patients throughout their interaction with the i-Diagnose, as they can click on an icon that gives detailed help about the current section of the interface that they are experiencing. PCI is also equipped with a chat facility where patients can chat to the PCI community patients about their concerns or ask for help.

The PCI gives the UK patients an indication of personal achievements, and that the interface is personalised to their preferences, while it gives the UAE patients a sense of society and that they are connected, and they can get help whenever they need. The PCI design approach reduced the negative effect of IND compared to the NPCI; this is evidence that the threat of individualism/collectivism in e-Health web-based services can be reduced by engineering designs that are capable of supporting patients and are also able to connect them to the immediate or Internet society when they need help.

Tangibility

e-Health web-based services are physically intangible. This is in contrast to the physical tangibility of face-to-face delivered services. In addition to their physical intangibility, e-Services can also be difficult to understand so could also be described as “mentally intangible” (Cuendet et al., 2015).

One of the problems encountered measuring this concept is that it is, by its very nature, something that is difficult to measure when it is not present (intangible). Thus, if e-Health systems were inherently intangible, cues would be required for patients to evaluate these systems.

One description of how the tangibility of the patient interface can be measured in practice is by measuring the patients’ belief that they have a ‘clear picture’ of the service/item that they have evaluated (Maquil, 2015). The method used to look at the effect of Tangibility in the present study was to incorporate it as one of the design components. To do this, multimedia objects were used to make the system tangible by acting as visual aids to provide a ‘clear picture’.

Tangibility was measured by the following statement:

To evaluate Tangibility, the concept has been measured by (averaged responses):

- i-Diagnose self-diagnostic features helped me form a positive attitude towards online health services.
- i-Diagnose can be a relatively acceptable alternative to speaking with a doctor face to face to check my symptoms.

There may be some argument about whether this measures ‘tangibility’ or ‘positivity’ with the e-health system in general. Therefore, the underlying assumption made with this measure is that a *tangible* experience is a positive one.

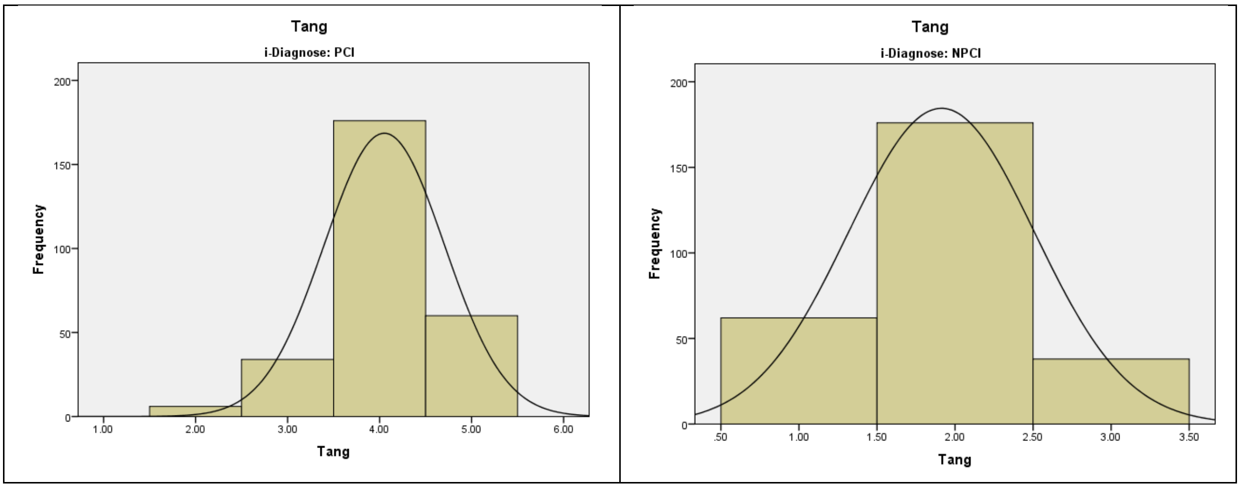

Figure 68: Distribution of Tangibility Responses

The UK Tangibility statistics (M=4.01, SD=0.88) for PCI patients and for NPCI (M=1.93, SD=0.78), while for the UAE (M=4.09, SD=0.29) for PCI and (M=1.89, SD=0.31) for NPCI. Both the UK and the UAE patients who used the NPCI (multimedia elements not present) reacted negatively, as can be seen in the mean and SD values. The histogram (Figure 68) illustrates the collective (UK and UAE) data distribution of tangibility.

Tangibility was significantly correlated with ASU (r=0.896, p < 0.0001). An independent-samples t-test was conducted to compare the influence of Tangibility on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.05, SD = 0.59) and NPCI (M = 1.91, SD = .70); t = 40.15 (df = 550), p < 0.0001.

The Tangibility *pSat* indicated that PCI Tangibility interface design approach enhanced the patient's satisfaction by 43% (table 4), which was further supported by η^2 = 0.75.

The UAE is classified as a high UA culture (Hofstede, 1984); the UAE PCI participants expressed moderate positive attitudes towards e-Health web-based services. The UAE citizens prefer face-to-face services, which indicate a higher level of tangibility compared to participants from the UK. However, the results from the analysis do not support this hypothesis as, it would appear, that there are no cultural differences in regards to *overall* tangibility. However, the analysis found that the tangibility of the e-Health interface is associated with the interface used. UAE patients had a slightly higher level of tangibility for the PCI system than UK patients did. In general, though, PCI interfaces appear to be more tangible than NPCI interfaces regardless of culture.

These results suggest that tangibility does have a significant effect on e-Health web-based services acceptance and that the more tangible a system is perceived, then the more likely patients will accept and use the system. The negative effects of e-Health systems' intangibility should be reduced by improved HCI and multimedia considerations to provide stronger tangible cues of e-Health web-based services benefits.

Trust

The study investigated the patients' trust in using i-Diagnose as a service channel.

Trust was measured by the following statement:

- i-Diagnose is safe and I do not fear that my personal data may be stolen or misused.

Clearly, due to confidentiality, e-Health web-based services should only ask patients for personal information if it is likely to improve the service received by the patient.

There are two aspects to this principle. Firstly, a patient's sensitive medical information will be required for purposes of concise diagnosis. Secondly, financial information may be required to pay for a chargeable e-health service. In this scenario, the patient should feel safe about providing her/his financial information. This can be achieved by displaying the security measure that the site is adopting to safeguard patients' details and transactions.

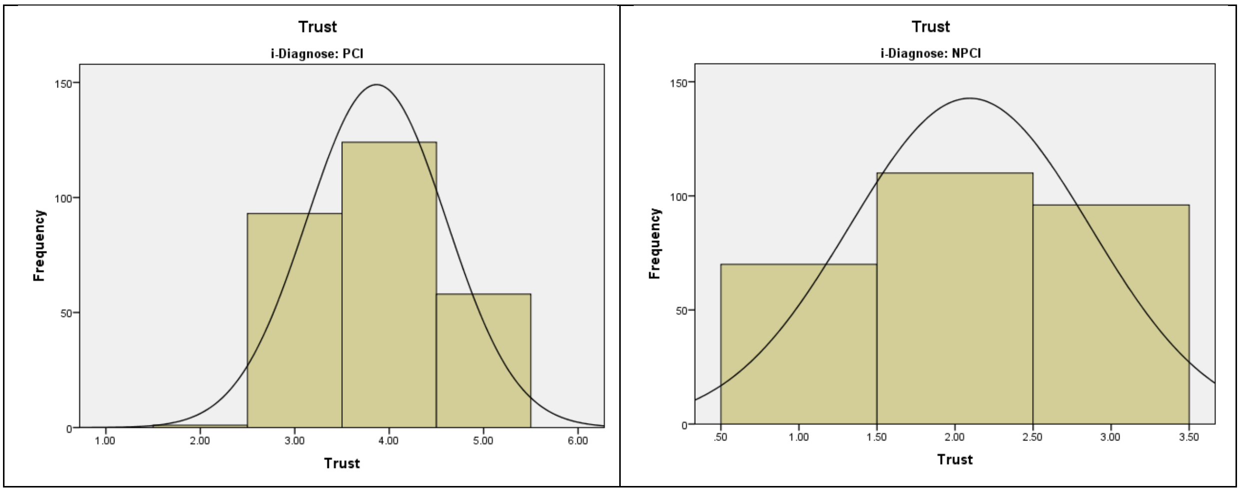

Figure 69: Distribution of Trust Responses

The UK Trust statistics (M=3.95, SD=0.85) for PCI patients and for NPCI (M=2.06, SD=0.84), while for the UAE (M=3.78, SD=0.60) for PCI and (M=2.13, SD=0.69) for NPCI. The histogram (Figure 69) illustrates the collective (UK and UAE) data distribution of trust.

The data indicate that Trust was higher for the PCI system than the NPCI system. There were, however, no culture differences in Trust either overall or depending on the interface. Therefore, Trust is equally important to both cultures. These findings, therefore, indicate that the interface is an important factor in Trust that is consistent across cultures

Trust was found to be significantly correlated with ASU (r=0.803, $p < 0.0001$). An independent-samples t-test was conducted to compare the influence of Trust on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 3.87, SD = 0.73) and NPCI (M = 2.10, SD = .77); t = 27.56 (df = 550), p < 0.0001.

The Trust *pSat* indicated that the PCI Trust interface design approach enhanced the patient's satisfaction by 35%(table 4), which was further supported by η^2 = 0.58.

Trust is important for persuading patients to use e-health systems. For example, if a patient feels threatened or are concerned about the possible misuse of their personal data, they would be reluctant to use the services. The above result infers that Trust has a high influence on whether patients would choose to use i-Diagnose or not. The significant correlation suggests that increasing an individual's trust in a system also increases that individual's intention to adopt it.

Subjective Norms (SN)

SN refer to a person's perception of social and group pressure. They are likely to indicate whether behaviour under consideration by a person is acted upon or not (Smith, 2015).

Subjective norms cannot be directly modelled in the interface; however, they are indirectly associated with intention to use through the effect patients can make on another's intention to use e-Health services. The more patients are attracted to the service and feel it is useful, easy to use, safe, enjoyable, error-free and serves their needs, the more likely they are to adopt it, which suggests that through their influence they can encourage others to use the service.

SN is measured by the following statement:

- People who influence my behaviour think that I should use e-Health web-based services

The UK SN statistics (M=4.01, SD=0.86) for PCI patients and for NPCI (M=1.94, SD=0.79), while for the UAE (M=4.09, SD=0.29) for PCI and (M=1.89, SD=0.31) for NPCI. The histogram (Figure 70) illustrates the collective (UK and UAE) data distribution of SN.

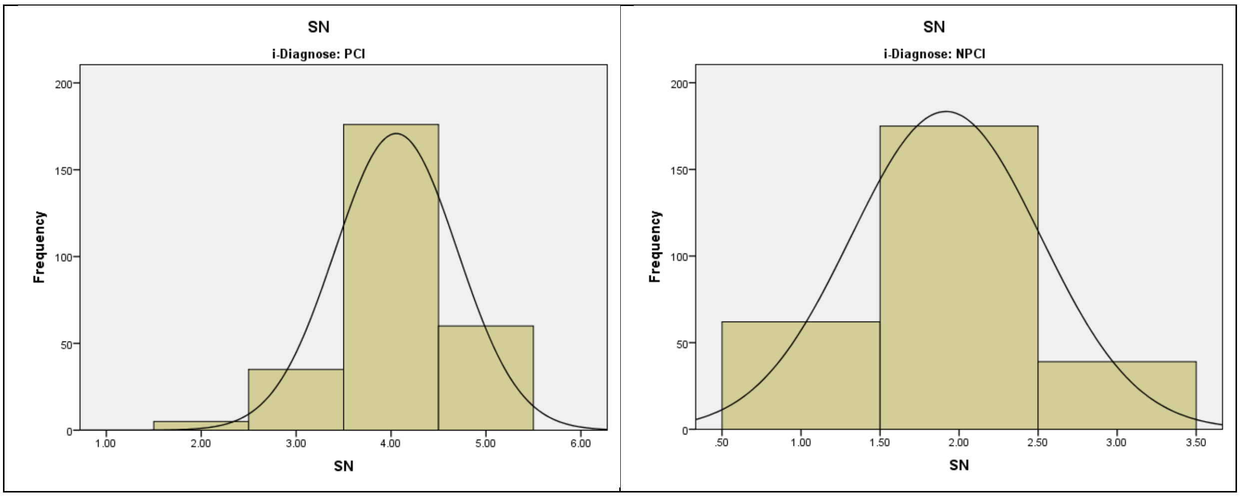

Figure 70: Distribution of Subjective Norms Responses

SN is significantly correlated with ASU (*r* = 0.837 p < 0.0001). An independent-samples t-test was conducted to compare the influence of SN on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.05, SD = 0.58) and NPCI (M =1.92, SD = .55); t = 40.33 (df = 550), p < 0.0001, which suggest that patients are influenced to use e-Health web based services by their superiors or key family members, if the services are useful.

Analysis of the collected data indicated that SN influences patients' intention to use e-Health web-based services. According to Gefen et al. (2003) and Khushman et al. (2009) collectivist cultures impose a higher social pressure on members to use Internet-based services if people in authority expect it. In general, the UK is thought to be a much more individualist culture than the UAE. Therefore, SN should have less impact on UK participants. However, the analysis did not find differences between UK and UAE in their respective levels of SN when this was mediated via the e-health system.

The findings in general are that cultural factors are important in orientations towards the use of the system. There are, however, very large differences in some cultural dimensions in relation to how well the different interfaces are accepted. Although the PCI interface seems to be generally more accepted, some cultural aspects are appreciated more depending on different cultural dynamics present in the UAE and UK.

5.3.2. Technology Acceptance Results for i-Diagnose Interface Design [H2]

This section will discuss the results obtained by Technology Acceptance Model's constructs. The figure below (Figure 71) illustrates the means for both the UK and UAE.

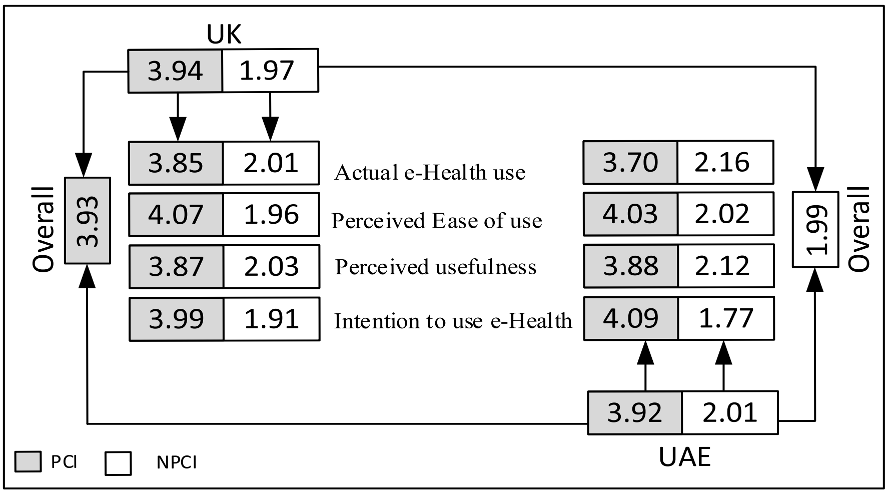

Figure 71: The means for Technology Acceptance Model constructs

Perceived Ease of Use (PEOU)

Within the context of this research PEOU refers to the i-Diagnose being neither too mentally or too physically demanding,

PEOU was measured by the following statement:

- I can easily diagnose myself through i-Diagnose

The UK PEOU statistics (M=3.99, SD=0.90) for PCI patients and for NPCI (M=1.92, SD=0.77), while for the UAE (M=4.12, SD=0.38) for PCI and (M=1.80, SD=0.40) for NPCI. The histogram (Figure 72) illustrates the collective (UK and UAE) data distribution of PEOU.

PEOU was found to be significantly correlated with ASU (*r*=0.795, *p* < 0.0001). An independent-samples t-test was conducted to compare the influence of PEOU on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.06, SD = 0.64) and NPCI (M =1.86, SD = 0.44); t = 39.24 (df = 550), p < 0.0001.

The PEOU *pSat* indicated that PCI PEOU interface design approach enhanced the patient's satisfaction by 44% (table 4), which was further supported by $\eta^2 = 0.74$.

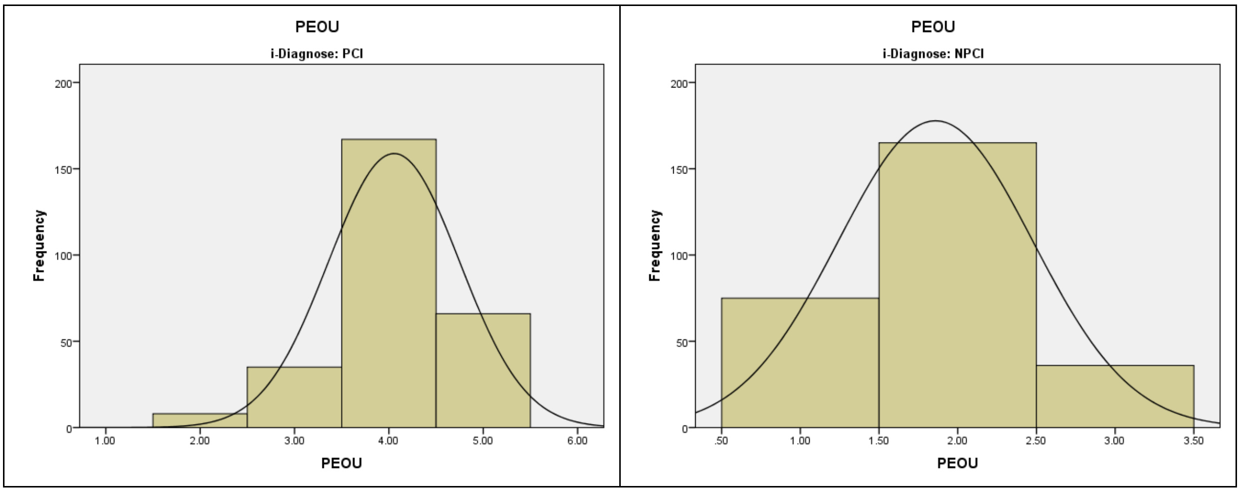

Figure 72: Distribution of Perceived Ease of Use Responses

The PEOU results for NPCI results indicated that this version of i-Diagnose is not easy to use. This is due to the interface where all the interactive patient-centered features are disabled. The results indicated that the participants preferred the PCI system that was easier for the patient to navigate.

If the system is not easy to use, patients might not understand how to perform tasks. This may impose stress on their mental mode and make them feel uncomfortable when using the service. In turn, this will negatively affect whether they would want to use the system.

Perceived Usefulness (PU) [HP-4]

PU was measured by the following statements (averaged responses):

- Information provided by i-Diagnose is useful
- i-Diagnose helped me understand more about diabetes

The UK PU statistics (M=4.45, SD=0.53) for PCI patients, and for NPCI (M=2.32, SD=0.78), while for the UAE (M=4.48, SD=0.51) for PCI and (M=2.41, SD=0.49) for NPCI. The histogram (Figure 73) illustrates the collective (UK and UAE) data distribution of PU.

PU was found to be significantly correlated with ASU (r=0.899, $p < 0.0001$). An independent-samples t-test was conducted to compare the influence of PU on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.47, SD = 0.52) and NPCI (M =2.37, SD = 0.64); t = 41.52 (df = 550), p < 0.0001.

The PU *pSat* indicated that the PCI PU interface design approach enhanced the patient's satisfaction by 42% (table 4), which was further supported by η^2= 0.76.

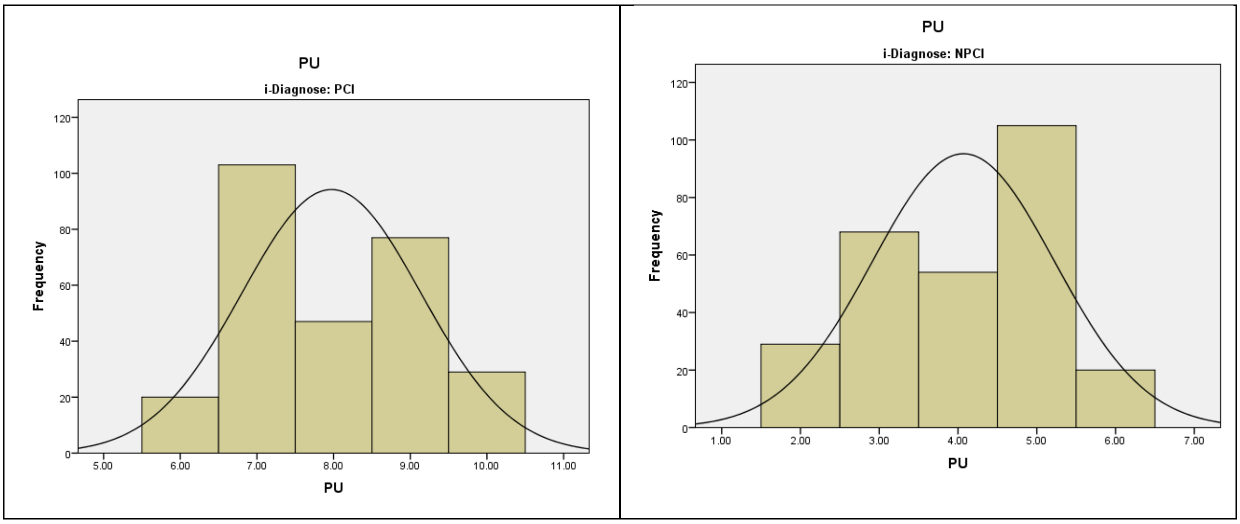

Figure 73: Distribution of Perceived Usefulness Responses

There were consistent differences across cultures with both the interface preferences and its usefulness, as the NPCI results indicated that this version of i-Diagnose was not useful. In contrast, those patients that used the PCI system acknowledged that the PCI interface was useful. Given that a high PU rating is strongly correlated with the overall usability of the system, then systems like PCI would be chosen as an e-Health system in order to increase the likelihood of use. Thus, it is expected to contribute to the promotion of a positive attitude towards the acceptance of e-Health web-based services.

Intention to Use e-Health (I2U)

I2U was measured by the following statement:

- I intend to use i-Diagnose (or similar online tools) to check my symptoms or book an appointment

The UK I2U statistics (M=4.52, SD=0.78) for PCI patients, and for NPCI (M=1.71, SD=0.75), while for the UAE (M=4.11, SD=0.32) for PCI and (M=1.66, SD=0.48) for NPCI. The histogram (Figure 74) illustrates the collective (UK and UAE) data distribution of IU2.

I2U was found to be significantly correlated to ASU (r =0.884, p< 0.0001). An independent-samples t-test was conducted to compare the influence of I2U on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.32, SD = 0.55) and NPCI (M =1.69, SD = 0.62); t = 40.89 (df = 550), p < 0.0001.

The I2U *pSat* indicated that PCI I2U interface design approach enhanced the patient's satisfaction by 53% (table 4), which was further supported by η^2 = 0.75.

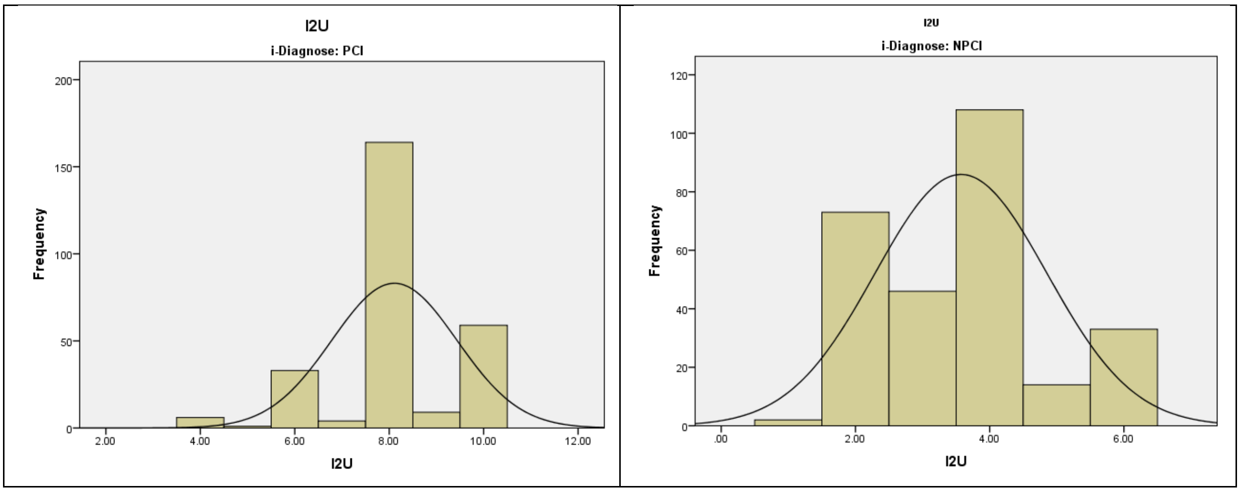

Figure 74: Distribution of Intention to Use e-Health Responses

The above results were expected, as the positive experiences measured in ASU would probably be related to their desire to use this kind of system more than once.

Intentions to use e-Health system in the future were much more likely when using the PCI interface. The NPCI results indicated that this interface was not good for encouraging future use. This was due to disabling patient-centred features in this interface. Thus, the culturally informed design approach that PCI offers can positively affect the patients' behavioural attitude towards e-Health web-based services.

5.3.3. e-Health Technology Design Factors [H3]

The primary objectives of usability are to develop interactive usable interfaces that are easy to use, useful, effective and enjoyable to use from the patient's perspective. i-Diagnose measures usability through the Personalisation, Interactivity, Accuracy and Responsiveness items. The aim is to assess their impact on the patient's e-Health web-based services acceptance. i-Diagnose interaction involves dialogues with feedback and controls during the execution of a task.

Personalisation

Personalisation of services is currently at the forefront of e-Health design development. In the i-Diagnose context, Personalisation is understood as being the means through which individuals are able to manage, share and store their symptoms in a secure and conducive environment.

Personalisation was measured by the following statement:

- i-Diagnose knows who I am, and provides a tailored screen to suit me

The UK personalisation statistics (M=4.14, SD=0.69) for PCI patients, and for NPCI (M=1.89, SD=0.31), while for the UAE (M=4.48, SD=0.53) for PCI and (M=1.72, SD=0.45) for NPCI. The histogram (Figure 75) illustrates the collective (UK and UAE) data distribution of personalisation.

Personalisation was found to be significantly correlated to ASU (r =0.869, $p < 0.0001$). An independent-samples t-test was conducted to compare the influence of Personalisation on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.31, SD = 0.61) and NPCI (M =1.81 SD = 0.38); t = 55.57 (df = 550), p < 0.0001.

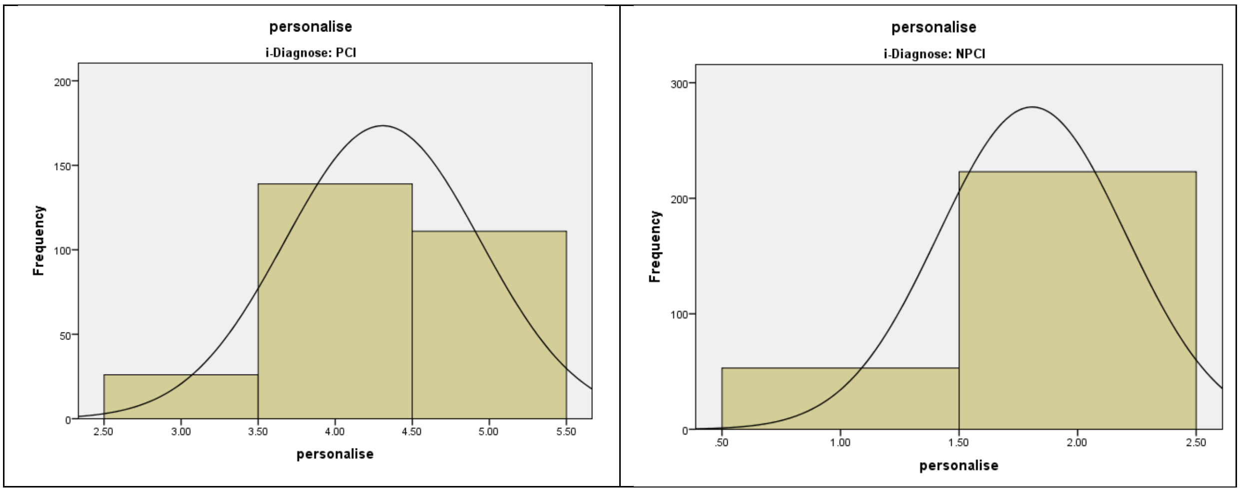

Figure 75: Distribution of Personalisation Responses

The Personalisation *pSat* indicated that the PCI interface personalisation design approach enhanced the patient's satisfaction by 50% (table 4), which was further supported by η^2 = 0.85.

The results indicated that providing personalised contents and relevant interface dynamics positively affects patient's satisfaction. The more the system is aware of the patients' background; the more it will be able to configure and deliver a personalised content, which will in-turn increase the likelihood of the e-Health systems being adopted.

Accuracy

Accuracy in the i-Diagnose context refers to how information is accurately supplied by the i-Diagnose system to serve a patient request. Patients can diagnose themselves, book an appointment and check their BMI and BMR; they expect the information returned by i-Diagnose to be valid and relevant to their query.

Accuracy was measured by the following statement:

- i-Diagnose provides an explanation whenever I can't access elements in the interface.

The UK accuracy statistics (M=4.34, SD=0.57) for PCI patients, and for NPCI (M=2.73, SD=1.28), while for the UAE (M=4.38, SD=0.54) for PCI and (M=1.99, SD=0.68) for NPCI. The histogram (Figure 76) illustrates the collective (UK and UAE) data distribution of accuracy.

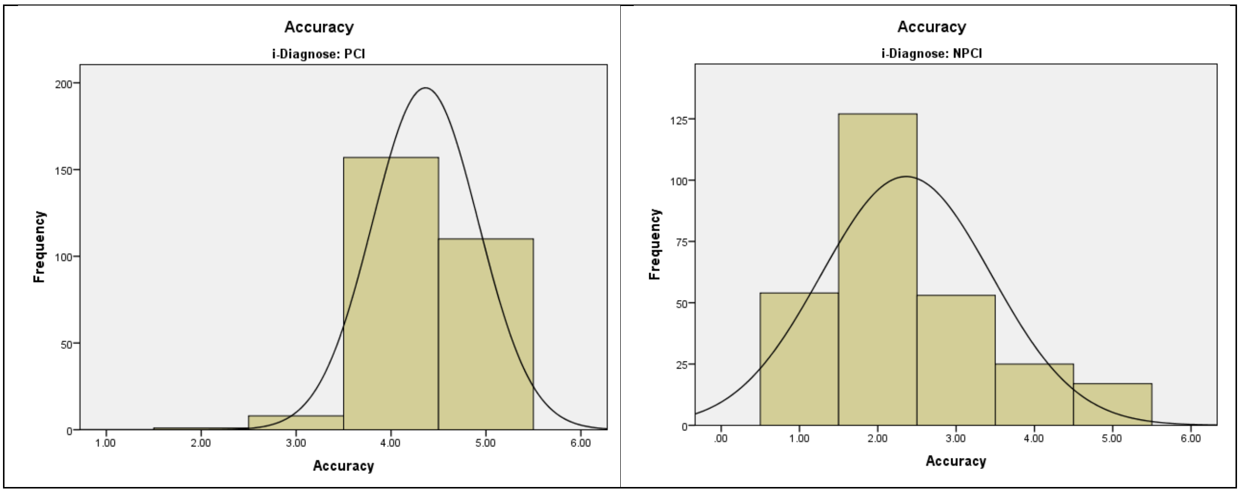

Figure 76: Distribution of Accuracy Responses

Accuracy was found to be significantly correlated to ASU (r =0.762, $p < 0.0001$). An independent-samples t-test was conducted to compare the influence of accuracy on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.36, SD = 0.56) and NPCI (M =2.36 SD = 0.98); t = 27.23 (df = 550), p < 0.0001.

The accuracy *pSat* indicated that PCI interface accuracy design approach enhanced the patient’s satisfaction by 40% (table 4), which was further supported by η^2 = 0.57.

Accuracy results show that there is a much higher level of perceived accuracy when using the PCI version of i-Diagnose with interactivity features. Accurate information is associated with relevance. Therefore, an increased level of accuracy enables the system to return relevant information to the patients. It can be inferred from these results that the use of the PCI interface would increase their behavioural intention to accept the e-Health technology.

Responsiveness

Responsiveness measures the time the system takes to provide feedback or respond to a patient’s query.

Responsiveness was measured by the following statement:

- When I click on an option i-Diagnose returns the result quickly (the response rate is acceptable).

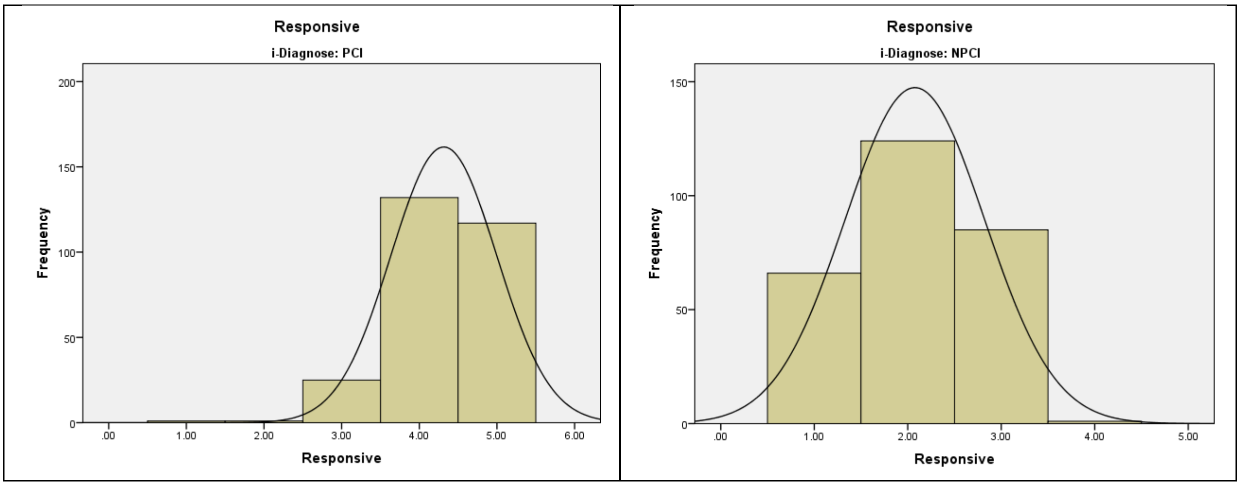

Figure 77: Distribution of Responsiveness Responses

The UK responsiveness statistics (M=4.23, SD=0.79) for PCI patients, and for NPCI (M=2.10, SD=0.79), while for the UAE (M=4.40, SD=0.55) for PCI and (M=2.05, SD=0.70) for NPCI. The histogram (Figure 77) illustrates the collective (UK and UAE) data distribution of responsiveness.

Responsiveness was found to be significantly correlated to ASU (r =0.817, p < 0.0001). An independent-samples t-test was conducted to compare the influence of responsiveness on i-Diagnose acceptance. There was a significant difference in the scores for (M = 4.32, SD = 0.67) and NPCI (M =2.08 SD = 0.75); t = 36.8 (df = 550), p < 0.0001.

The responsiveness *pSat* indicated that PCI interface responsiveness design approach enhanced the patient's satisfaction by 45% (table 4), which was further supported by η^2 = 0.71.

The results indicated that the PCI interface was far superior in being responsive than the NPCI interface. Responsiveness positively affects performance, as the more time the system needs to satisfy a patient's input or request, the fewer patients are likely to embrace the performance or robustness of the system.

5.3.4. Assessing the Significance of the Gender Factor [H4]

According to Livingston (2005), gender plays an important moderating effect in people's decision-making processes by influencing the acceptance of Internet-based systems. In Livingston's study, male patients considered PU to be more important than female patients. In contrast, in making decisions regarding the use of Internet-based technologies, female patients were concerned with PEOU more than male patients.

Independent samples t-tests were used to investigate whether there were any differences in the responses between male and female patients. For this purpose, the assumption is that the distribution of the responses would be similar across interfaces regardless of gender. Gender was evenly split across all conditions with 69 males and females in each culture in each interface condition (PCI and NPCI). Therefore, the assumption of an even distribution of responses across conditions was likely to be reasonable. Furthermore, the purpose of this analysis was to get a general indication of whether Gender was an important issue that required further investigation.

Gender statistics in table 5 shows the responses by gender over the fifteen measured items; overall, there were only two significant differences. The first difference was in the responses to Accuracy (*t*=2.55, *p* < 0.0110) where males deemed i-Diagnose interfaces to be more accurate than females (Male mean=3.50, Female mean=3.21). The second difference was a similar response pattern for Responsiveness (*t*=3.36, *p* < 0.0008). Here, males deemed i-Diagnose interfaces to be more responsive on average than females (Male mean=3.38, Female mean=3.01). With these two exceptions, overall, there was not a large impact of patient gender on the results.

Table 5: ASU t-test Comparisons by Gender

Item	**Gender (Mean – SD)**		**t-value df(550)**	**sig**	***η2***
	Male n=276	**Female n=276**			
PD	**3.30 -** 1.45	**3.29 -** 1.38	0.08	0.9401	0.00
MAS	**2.99 -** 1.26	**2.79 -** 1.30	1.76	0.0786	0.01
UA	**3.28 -** 1.34	**3.11 -** 1.33	1.50	0.1352	0.00
IND	**3.44 -** 0.93	**3.37 -** 0.87	0.99	0.3207	0.00
TANG	**2.93 -** 0.84	**2.95 -** 0.85	-0.35	0.7246	0.00
TRSU	**2.99 -** 1.15	**2.97 -** 1.18	0.26	0.7983	0.00
SN	**2.96 -** 1.25	**3.03 -** 1.18	-0.67	0.5050	0.00
PEOU	**3.08 -** 1.29	**3.04 -** 1.43	0.34	0.7315	0.00

PU	**2.99** - 1.18	**3.03** - 1.09	-0.32	0.7505	0.00
12U	**2.97** - 1.26	**2.94** - 1.30	0.27	0.7905	0.00
Personalisation	**3.11** - 1.33	**3.00** - 1.39	0.94	0.3475	0.00
Interactivity	**2.89** - 0.94	**2.89** - 0.92	0.09	0.9272	0.00
Accuracy	**3.50** - 1.36	**3.21** - 1.28	2.55	**0.0110**	0.01
Responsiveness	**3.38** - 1.23	**3.01** - 1.39	3.36	**0.0008**	0.02
Actual System Use	**3.31** - 1.26	**3.34** - 1.19	-0.35	0.7284	0.00

The next section will validate e-HTAM (chapter 3) in light of the findings of the i-Diagnose results.

5.4. Validating the e-HTAM model

e-HTAM that was presented in the chapter three, validated the intention to use e-Health amongst the sampled population. Actual use could not be validated due to the absence of a prototype built specifically to assess the acceptance of e-Health. The analysis of i-Diagnose presented in the above sections provided a means of testing the actual use of e-Health web based services.

Table 6: Comparison of e-HTAM states

	e-HTAM (I2U)	e-HTAM (ASU) via i-Diagnose
Technology Design factors	*r* = .392, p<.0001	*r* = .819, p<.0001
Sociocultural factors	*r* = .393, p<.0001	*r* = .848, p<.0001
Technology Acceptance factors	*r* = .606, p<.0001	*r* = .977, p<.0001

e-HTAM factors (chapter 3) retained their significance when employed in i-Diagnose (table 6). The correlation between the e-HTAM factors and i-Diagnose ASU was higher compared to e-HTAM and I2U.

Although there were similarities, the technology acceptance factor exhibited a higher correlation, indicating that the usefulness and the perceived ease of use of the e-Health system are crucial elements that can play a big role in terms of patients' adoption of such emerging technologies.

To better understand the magnitude of the difference, ASU will be assessed based on the data collected during i-Diagnose evaluation.

The ASU was quantified in the evaluation by the answers to three questions (averaged responses):

- The i-Diagnose interface is intuitive
- Information provided by i-Diagnose sounds valid
- Information provided by i-Diagnose is relevant to diabetes

The means for the ASU results are shown in Figure 78 and (table 4). The UK ASU statistics (M=4.50, SD=0.31) for PCI patients, and for NPCI (M=2.13, SD=0.58), while for the UAE (M=4.46, SD=0.28 for PCI and (M=2.24, SD=0.33) for NPCI.

An independent-samples t-test was conducted to compare ASU on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.48, SD = 0.29) and NPCI (M =2.19, SD = 0.46); t = 73.41 (df = 550), $p < 0.0001$.

The ASU *pSat* indicated that the i-Diagnose ASU interface design approach enhanced the patient's satisfaction by 46% (table 4), which was further supported by $\eta^2 = 0.89$.

The above results were further supported by the results obtained from the interactivity features of the PCI, where the UK interactivity statistics (M=4.51, SD=0.25) for PCI patients, and for NPCI (M=2.02, SD=0.56), while for the UAE (M=4.46, SD=0.24) for PCI and (M=2.30, SD=0.29) for NPCI.

Interactivity was found to be significantly correlated to ASU (r =0.733, $p< 0.0001$). An independent-samples t-test was conducted to compare the influence of responsiveness on i-Diagnose acceptance. There was a significant difference in the scores for PCI (M = 4.49, SD =0.25) and NPCI (M =2.16, SD =0.43); t = 31.32 (df = 550), $p < 0.0001$.

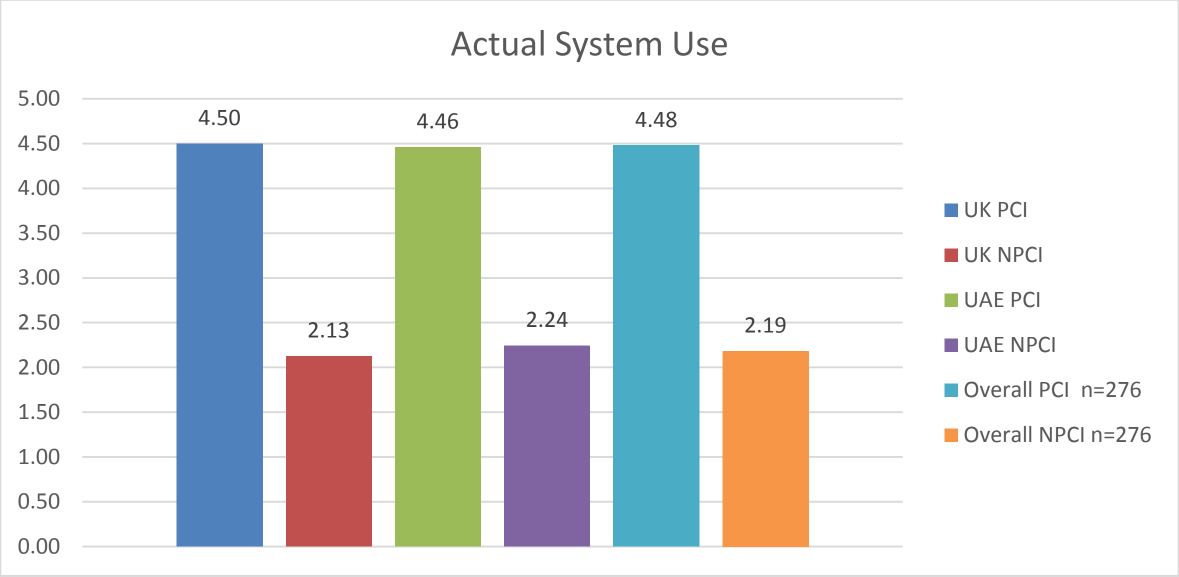

Figure 78: i-Diagnose Actual System Use

The interactivity features of PCI *pSat* indicated that the PCI interface interaction design approach enhanced the patient's satisfaction by 47% (table 4), which was further supported by η^2= 0.64.

e-HTAM updated version based on the i-Diagnose ASU is demonstrated in figure 79.

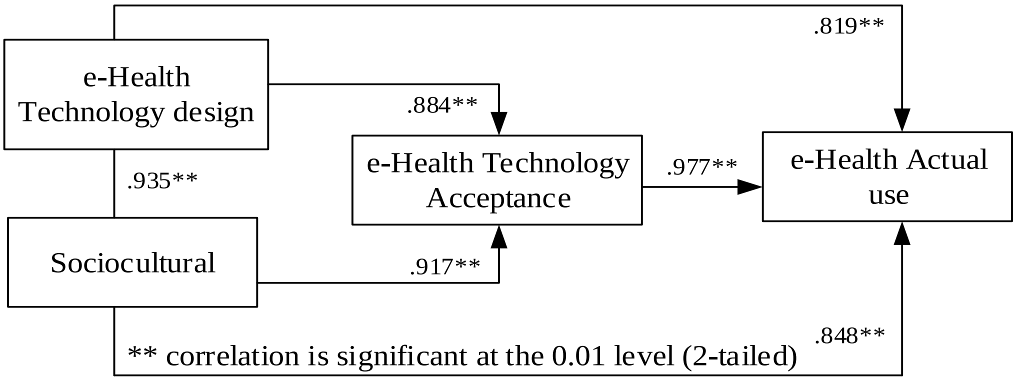

Figure 79: Final e-HTAM model based on the i-Diagnose ASU

The results indicate that an interactive environment is perceived as a useful feature, as it supports the patients while they are interacting with i-Diagnose. Poor interaction negativity affects the usability of any system, which in turn impacts the overall effectiveness of i-Diagnose and the patients' e-Health technology adoption.

Although the differences between the UK and the UAE in terms of the culture is evident and well established (Mohamed et al., 2011, 2012; Hofstede, 1984; Khushman et al., 2009), the concept of PCCeDA positively reduced the impact of the differences between the two cultures. The above findings suggest that, when the PCI interface is used, the system is equally useable for both UAE and UK patients. However, the NPCI interface is more acceptable for UAE patients than for UK patients.

Therefore, the e-Health systems designer and policy makers could plausibly enhance e-Health web-based services usage through increasing the level of trust by employing methods such as cues, cultural awareness, usefulness, ease of use, certificates, testimonials and other similar strategies that are able to increase user trust in e-Health web-based services.

5.5. Summary

The PCCeDA framework was explored in this chapter through the i-Diagnose (proof of concept prototype). This approach was informed by the findings of e-HTAM presented in chapter three. The adaptive and personalised nature of the PCI interface, that is culturally-aware, was contrasted with the NPCI interface that was not culturally aware and was not patient centred.

The cultural factors showed that the PCI interface exhibited a lower PD, lower MAS, lower UA and lower IND compared to the NPCI interface. This is a finding across cultures but with smaller cultural differences indicated between the interfaces on the Individualism/Collectivism dimension. This finding implies that the appropriate inclusion of cultural factors into the e-Health design could positively influence the patients' attitude towards the acceptance of e-Health services.

However, it is arguable whether Hofstede's cultural indices accurately represent today's cultural paradigm. They were largely based on findings from the 1980s so may be less relevant when there have been so many changes in culture in the intervening period. The index calculation should have an adaptive and reflexive measures, where the system calculates the patient's cultural profile based on her/his current cultural state. Such use should, and PCI does, adaptively control a patient's profile to personalise the interface and the contents accordingly, while adhering to the PCCeDA principles. In contrast, the NPCI represents the current somewhat ‘static’ indexation of Hofstede while ignoring PCCeDA guidelines.

These results suggest that the more useful the interface is perceived to be, the more likely it is that the patients would accept and use it. Although PEOU reported a significant correlation with i-Diagnose ASU, it was PU which emerged to have a strong positive direct effect, which shows that i-Diagnose’s enhanced features were perceived to be effective, and this will contribute to a higher e-Health web-based services acceptance rate.

The Technology Design factors also indicated a very strong preference for the PCI interface over the NPCI. This finding, along with the findings regarding culture, acceptance and design, indicate very strong evidence of a preference for the PCI interface. Thus, the patient-centred culturally-aware design approach positively affected the patients’ behavioural attitude towards e-Health web-based services acceptance.

The major strengths of the PCI are the cultural awareness, content and interface adaptation and personalisation elements, as they allow the patients to have their own individual interface that suits their cultural profile.

Overall, PCCeDA proved to be of significant value if a proper implementation approach is adopted, as the majority of the patents indicated a much higher likelihood of willingness to use the system in the future.

Chapter 6: Conclusion and Future Directions

6.1.Conclusion

The thesis has demonstrated that the idea of a patient-centred, culturally-aware system design for e-Health web-based services has the potential to address issues relating to the uptake and acceptance of e-Health web-based services in various cultural contexts. e-Health applications are typically designed in Western countries, and usually provide one static view of the interface that hardly takes into account the needs of patients in other cultures. When they are transferred to other parts of the world, their patient acceptance is ultimately affected and inhibited primarily because of differences in cultural orientations. Current trends in interface personalisation have, to some extent, addressed problems in interface design through visible elements such as fonts, language and colours. However, aspects of cultural modelling of the patient have largely remained under-explored, which negatively affects the adoption and market share of these e-Health web-based technologies in other (non-Western) cultures.

There is therefore a need to embed a flexible and culturally-aware approach in the design of e-Health web-based services in order to counter the predominant ‘one size fits all’ design approach of existing e-Health web-based applications, and more effectively cater for the needs of patients in various cultural contexts. This becomes not only relevant but also appropriate, as people increasingly access healthcare information and seek diagnosis on the Internet, and as more health organisations move towards electronic informatics for an enhanced patient experience.

To contribute to addressing these challenges, this thesis has proposed an approach for incorporating the notion of cultural awareness into the design of e-Health web-based applications in order to enhance their usability and adoption across cultures. The main research question that has guided this inquiry is ‘How can e-Health web-based services be designed in a way that fits into the cultures of individual patients for their better patient adoption of health information systems?’. We hypothesised that integrating culture into a technology acceptance model while catering for usability would positively improve the usability of e-Health web-based applications and enhance adoption and patient satisfaction.

The study included an extensive literature review out of which Hofstede’s (1984) cultural dimensions and Davis’s (1989) Technology Acceptance Model (TAM) were identified for defining and representing a patient’s cultural context. They were both combined to develop a culturally-aware e-Health Technology Acceptance Model, **'e-HTAM'**, (Chapter 3), and to develop and validate an e-Health technology acceptance model that incorporates cultural and technological factors (objectives 1 and 2). e-HTAM results revealed that cultural dimensions, namely subjective norms, power distance, collectivism/individualism and uncertainty avoidance, along with perceived ease of use, perceived usefulness and e-Health technology design, were of a high significance when designing for culturally-aware e-Health web-based services. e-HTAM was used to inform the design and development of a patient-centred Culturally-aware framework for Health information systems (PCCeDA) (Chapter 4), which was subsequently employed to develop and evaluate a patient-centred culturally-aware e-Health information system as a proof of concept prototype for improved patient acceptance (objective 3). The key novelty in the PCCeDA framework is the development of a culturally-aware framework, which enables e-Health web-based applications to adaptively personalise the application's patient interface to various patient cultural preferences while adhering to usability principles. As a result, the interface and contents presented to the patient are both dynamically tailored to better suit the patient's cultural preferences, thereby increasing patient satisfaction, system adoption, and overall system performance.

To evaluate the PCCeDA, a proof of concept prototype called i-Diagnose (Chapter 4) was developed based on the PCCeDA framework to adaptively customise both the patient interface elements and application contents to fit a patient's cultural profile and preferences. i-Diagnose supports patient self-diagnosis, and allows patients to access online health information according to their preferences, book appointments, check their BMI, BMR and email their health record to their personal email addresses.

i-Diagnose was developed as a dynamic web-based application. Its main objective was to investigate and assess the effectiveness and usefulness of integrating cultural variables into the technology acceptance model, and to evaluate how such integration would enhance the acceptance of e-Health web-based applications across various cultural settings. While the i-Diagnose specification articulates the requirements to fully integrate the measurable cultural variables and technology design factors, it is important to clarify that only key functional features and data models are implemented as a proof of concept. In order to make the patient profile accessible by other online applications, the patient instance can be exported as OWL, RDF or XML for other systems to consume. This will make the patient profile a portable object that can be applied to newly accessed/developed systems, thus making the systems adapt their environment to suit the patient.

When a patient accesses i-Diagnose for the first time, her/his major cultural markers are captured by i-Diagnose and used to create a patient profile. This initial profile is classified as Limited, Transit or Full. Based on the profile classification, i-Diagnose customises the interface and the contents to suit the patient. i-Diagnose monitors patient interaction behaviours, based upon which the patient's profile can be elevated from 'Limited' to 'Full', or downgraded to 'Transit'.

User-based evaluation of i-Diagnose with study participants from two culturally diverse regions (UK and UAE) was conducted to evaluate the effectiveness of the prototype. The results (Chapter 5) revealed that patient-centred Culturally-aware Design features (PCI) increased task completion rate by 90% for the diabetes diagnosis and appointment booking by 40% when compared to a non-patient-centred culturally-aware interface (NPCI). This reveals that a patient-centred design that integrates TAM constructs and cultural dimensions into the design of a e-Health web-based system enhances the system's overall usefulness and efficiency, which positively impacts system adoption and acceptability.

It can be summarised that the patient-centred culturally-aware design approach did positively affect patients' behavioural attitude towards e-Health web-based services acceptance, as the patients perceived it as easy to use, useful and catering for usability principles, while being interactive. The ability to adapt patient interface features to a patient's cultural preferences allowed the integration and representation of the cultural dimensions into the interface design, thus ensuring that patients have an interface that matches their individual cultural profiles. Although the i-Diagnose system has been developed according to the PCCeDA framework, the cultural variables used in defining the framework were originally developed by Hofstede (1984). Those cultural dimensions have been criticised as being outdated as the data was collected in the 1980s (Beugelsdijk et al., 2015; Jones, 2007). However, the dimensions appropriately classify patient cultural context into high and low, mapped into five different categories. One issue that negatively affects the dimensions is the accuracy, validity and flexibility of the indexation scale. Culture and technology have changed remarkably since the 1980s, so Hofstede's cultural values index hardly represent people's cultural states today. To reduce the negative effects of Hofstede's static indexation, this thesis integrated an adaption mechanism to resolve the static nature of the indexation of the cultural dimensions. The enhanced representation of the cultural dimensions has resulted in a more culturally-aware interface with greater ease of customisation; this in turn has led to increased patient satisfaction.

The impact of e-Health web-based services on society is increasingly noticeable through various web-based health applications, mobile devices; their benefits and applications will be more significant if more culturally-aware design principles are adopted.

This thesis has shown that incorporating the cultural dimensions, namely Power Distance, Uncertainty Avoidance, and Individualism/Collectivism along with Tangibility, Trust, Subjective Norms and patient-centred designed elements (Responsiveness, Accuracy, Interactivity and Personalisation) into the design of e-Health web-based applications improves patient satisfaction and overall acceptance and adoption, and as a result should be taken into consideration in the design and development of patient-centred health information systems.

6.2.Summary of Contributions

This research has contributed to the domain of e-Health by introducing the concept of a culturally-aware design approach to investigate the impact of culture on e-Health web-based services' acceptance.

The contribution is in the form of an e-Health acceptance model that incorporates technological, cultural and social variables. By developing a culturally sensitive technology acceptance model for e-Health (e-HTAM) and culturally-aware e-Health design framework. e-HTAM incorporates cultural dimensions as a way of enhancing the acceptance of e-Health web-based technologies.

Another contribution is the implementation of a Culturally-aware e-Health Design Approach framework 'PCCeDA' that allows the personalisation of both the patient interface and application contents provided to a patient to better suit that patient's cultural background.

The research also sheds light on addressing Hofstede dimensions' indexation (Hofstede, 1980, 1984, 1991, 2011), through the use of culturally-aware personalisation for modelling patients' cultural contexts. The research also sheds light on enhancing the understanding of the effect of cultural factors on the patients' perceived acceptance of e-Health information systems through a study of two culturally diverse regions, the UAE and the UK.

6.3.Limitations and Future Directions

Although the work presented in this thesis has addressed a number of issues for embedding a culturally-aware approach into the design of e-Health web-based systems domain as a way of improving the acceptability and adoption of such systems, some issues have remained unconsidered. The following points outline directions for extending this research work:

- A modelling of Hofstede's indexation to reflect the current state of an individual patient's cultural context, as many researchers still use Hofstede's (1984) data.
- A wider study sample that includes participants from other cultural regions and countries, as well as people of diverse social status, e.g. the elderly, in order to better generalise the results.
- Because this research is patient-centric, it has focused on patients as the only stakeholders interacting with an e-Health web-based system. Ideally, any e-Health web-based application includes healthcare professionals (doctors, nurses, pharmacists, etc.). As a result, an extension of the model would consider the incorporation and discussion of interactions with other non-patient stakeholders, including family members, the elderly, etc., for a complete interaction design.
- Deep learning is an emerging field within the domain of Artificial Intelligence that can learn from the patients' interactions and make decisions based on their behavioural interactions. The findings of this research could be used to set the parameters for such future applications.
- Explore the design, development and evaluation of an m-Health, patient-centred, culturally-aware mobile client that is based on the findings of this research, to further assess its acceptability in a mobile environment.
- Investigate and assess the benefits of developing the i-Diagnose prototype as a cloud-based service.
- As this research only tested UK and UAE participants, there is a need for further data to be collected from other different cultures to test the generalisability of the framework, assess the applicability and confirm it fits well with different cultural fabrics and work domains.

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Appendices

Appendix A: Pseudo codes

pseudocode 1: Exposing the patient instance as XML schema

```
if the requested output is OWL, then
            connect to the database
            Read the patient data
            while there is a data in the array
             for each element
              export the array element as OWL
endif
close database connection
```

pseudocode 2: A patient instance exposed as OWL and RDF

```
store data in array
set the header as RDF description
display header
iterate through the array
            for each element in the array
             wrap the element as xml object
             display the element as fieldname->data
 end iteration
```

pseudocode 3: Function to detect country of access

```
Read IP address
Connect to database
Search for marching country
if exist
    set language as default
Else
    set English language as default
end if
close database connection
```

pseudocode 4: Delete appointment

```
Read appointment Id from the URL
Connect to database
search for appointment by Id
if found
  delete
else
  print 'appointment not found'
endif
close database connection
```

pseudocode 5: BMR and BMI calculation

```
define BMI as (Weight in Pounds / (Height in inches) x (Height in inches)) x 703
define Women BMR as (655 + (4.35 x weight in pounds) + (4.7 x height in inches) - (4.7 x age in years))
define Men BMR as (66 + (6.23 x weight in pounds) + (12.7 x height in inches) - (6.8 x age in year))

if Little to no exercise, then
  Daily calories needed = BMR x 1.2
  activity = 1.2
if Light exercise (1-3 days per week), then
  Daily calories needed = BMR x 1.375
  activity = 1.375
if Moderate exercise (3-5 days per week), then
  Daily calories needed = BMR x 1.55
  activity = 1.55
if Heavy exercise (6-7 days per week), then
  Daily calories needed = BMR x 1.725
  activity = 1.725
if Very heavy exercise (twice per day, extra heavy workouts), then
  Daily calories needed = BMR x 1.9
  activity = 1.9
end if
```

```
calculate activity
  extra_energy = BMR * activity
  energy_needs =round (BMR + extra_energy)
  display calories needed per day
end activity calculator
Display patient’s BMR
if the patient’s BMI <= 18.5, then
  'You are underweight'
elseif BMI > 18.5 and BMI <= 24.9
 display 'You are at your normal weight'
elseif BMI > 24.9 and BMI <= 29.9
 display 'You are overweight'
elseif BMI > 29.9 and $BMI <= 39.9
 display 'You are obese'
else
 display 'You are morbidly obese'
endif
```

pseudocode 6: Delete symptoms

```
Read symptom Id from the URL
Connect to database
search for symptom by Id
if found
  delete
else
  print 'symptom not found'
endif
close database connection
```

pseudocode 7: PHP script to gather and email health records

```
Read patient ID
connect to database
retrieve all patients’ associated medical records
email records to patient
```

pseudocode 8: Exception catcher

```
start exception catcher
 if there is new exception, then
      catch and hide
      log the exception
endif
```

pseudocode 9: Form validation

```
read the form values on submission
 store them as an array
iterate through the array
  for each item in the array
    validate
    Display error message if the data is invalid
    ask the patient to re-enter the data
End iteration
```

pseudocode 10: Integrate Google translation API

```
call Google_Client.php
call Google_TranslateService.php
Read IP address
Detect country and native language
include google_Clinet and Google_TranslateService objects
Initialise the client’s object
Extend the Client’s object as GoogleTranslate
Call setDeveloperKey on the Client’s object
Initialise service as an object
Extend service as Client’s object
Initialise Language as an object
Extend language as service
set language = service->languages->userPreferredLang ()
```

Appendix B: The prototype screen shots

Figure 80: Login page

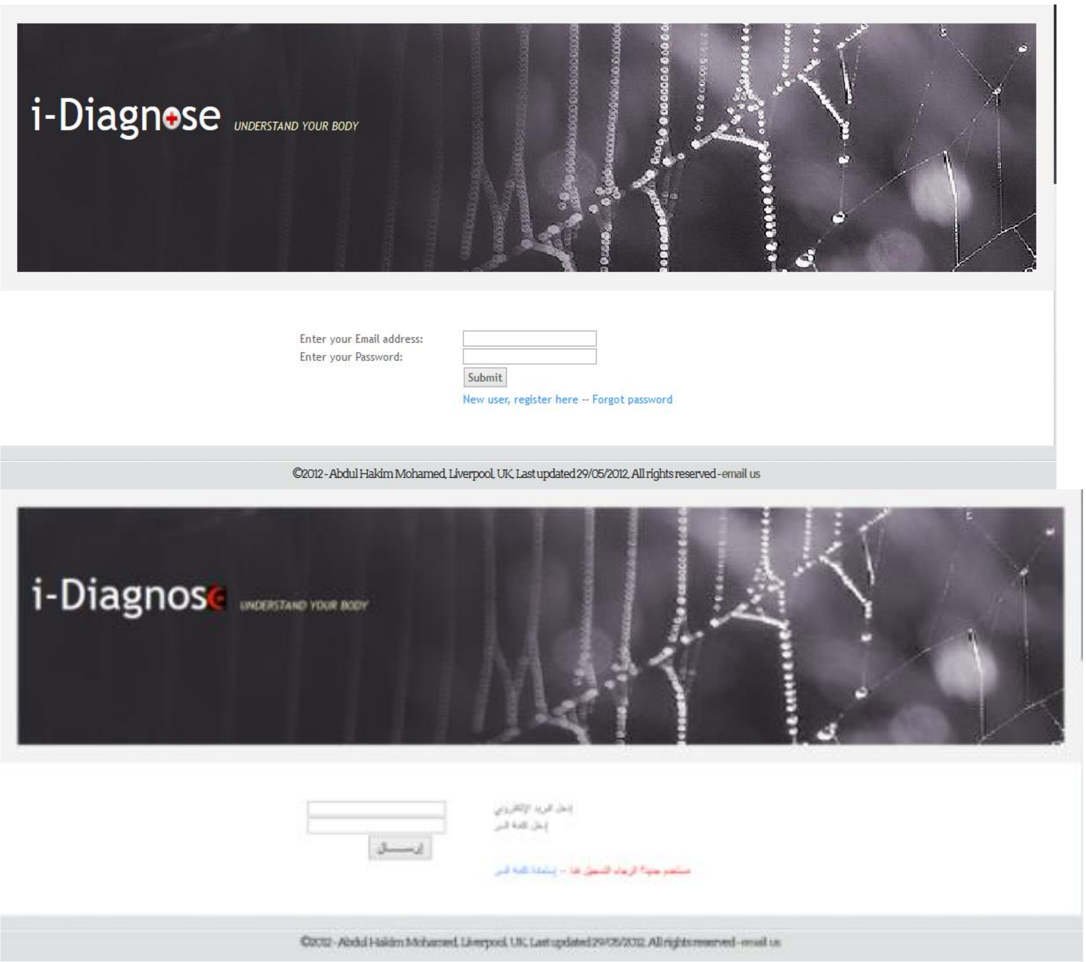

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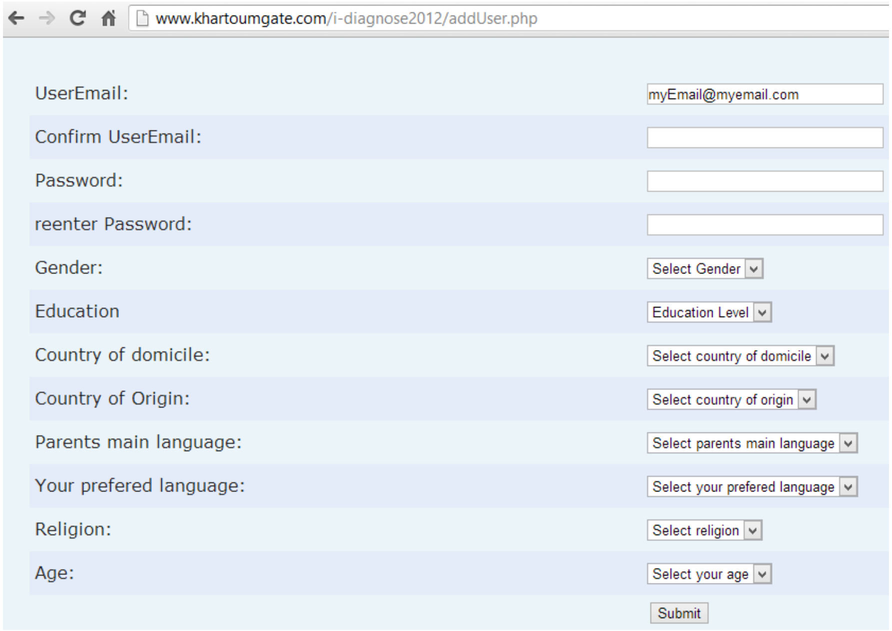
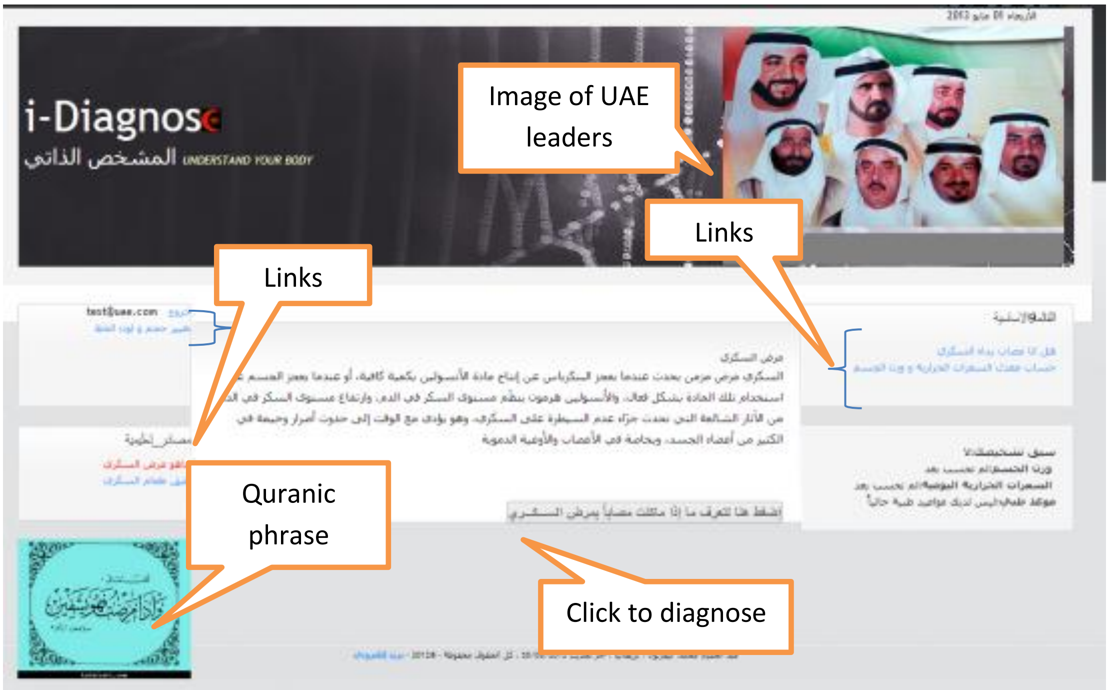
Figure 81: Patient registration (initial knowledge acquisition)



www.khartoumgate.com/i-diagnose2012/addUser.php

UserEmail:	myEmail@myemail.com
Confirm UserEmail:	
Password:	
reenter Password:	
Gender:	Select Gender
Education	Education Level
Country of domicile:	Select country of domicile
Country of Origin:	Select country of origin
Parents main language:	Select parents main language
Your prefered language:	Select your prefered language
Religion:	Select religion
Age:	Select your age

Figure 82: Typical Arabic 'Limited' state profile interface

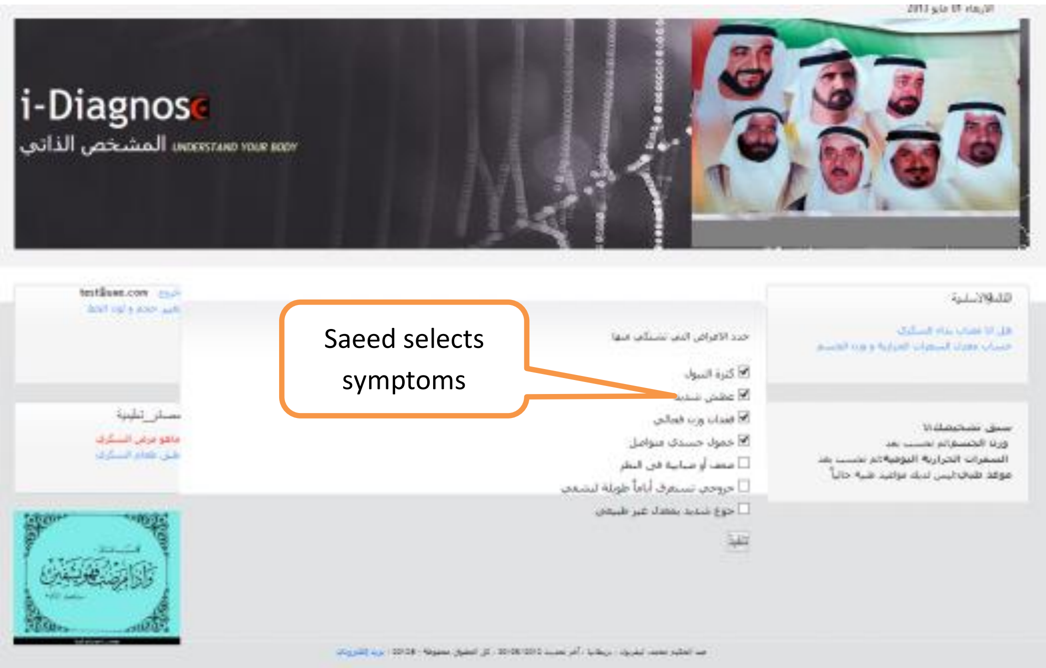


مرض السكري

السكري مرض مزمن يحدث عندما يعجز البنكرياس عن إنتاج مادة الأنسولين بكمية كافية، أو عندما يعجز الجسم
استخدام تلك المادة بشكل فعال. والأنسولين هرمون ينظّم مستوى السكر في الدم. وارتفاع مستوى السكر في
من الآثار الشائعة التي تحدث جراء عدم السيطرة على السكري، وهو يؤدي مع الوقت إلى حدوث أضرار وخيمة في
الكثير من أعضاء الجسد، وبخاصة في الأعصاب والأوعية الدموية

اضغط هنا لتعرف ما إذا كنت مصاباً بمرض السكري

Figure 83: Diabetes-related symptoms

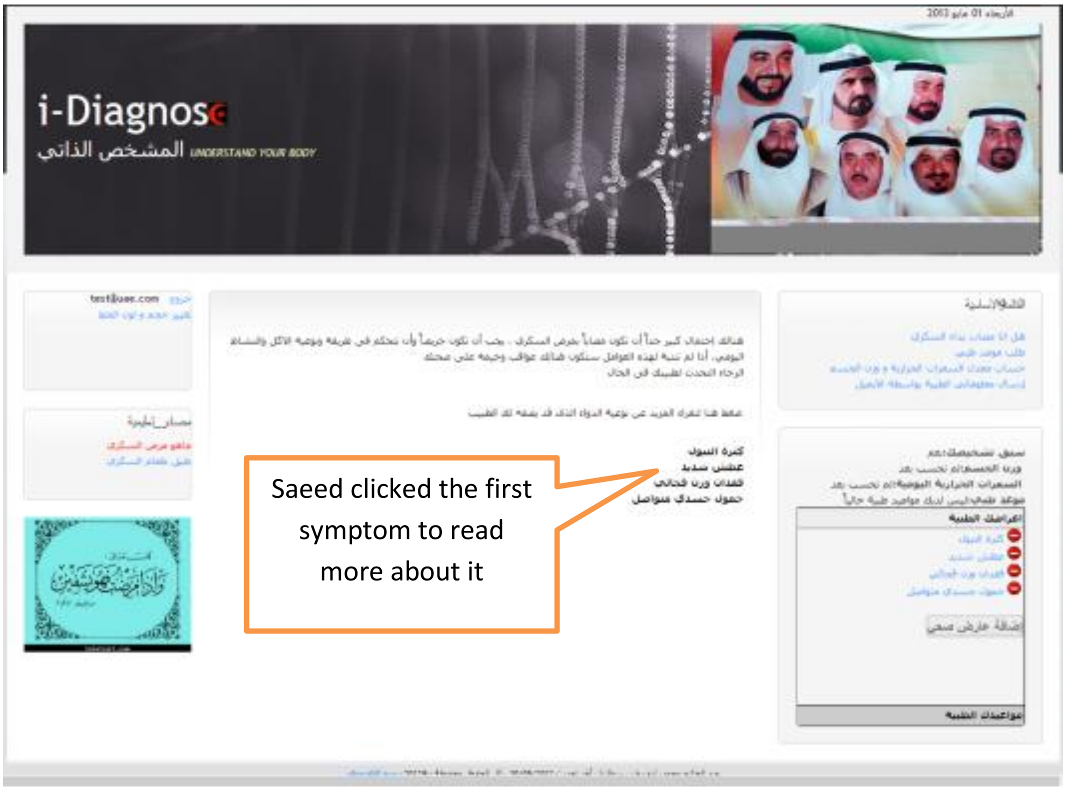


حدد الاعراض التي تشتكي منها

- ☑ كثرة التبول
- ☑ عطش شديد
- ☑ فقدان وزن فجائي
- ☑ خمول جسدي متواصل
- ☐ ضعف أو ضبابية في النظر
- ☐ جروح تستغرق أياماً طويلة لتشفى
- ☐ جوع شديد بشكل غير طبيعي

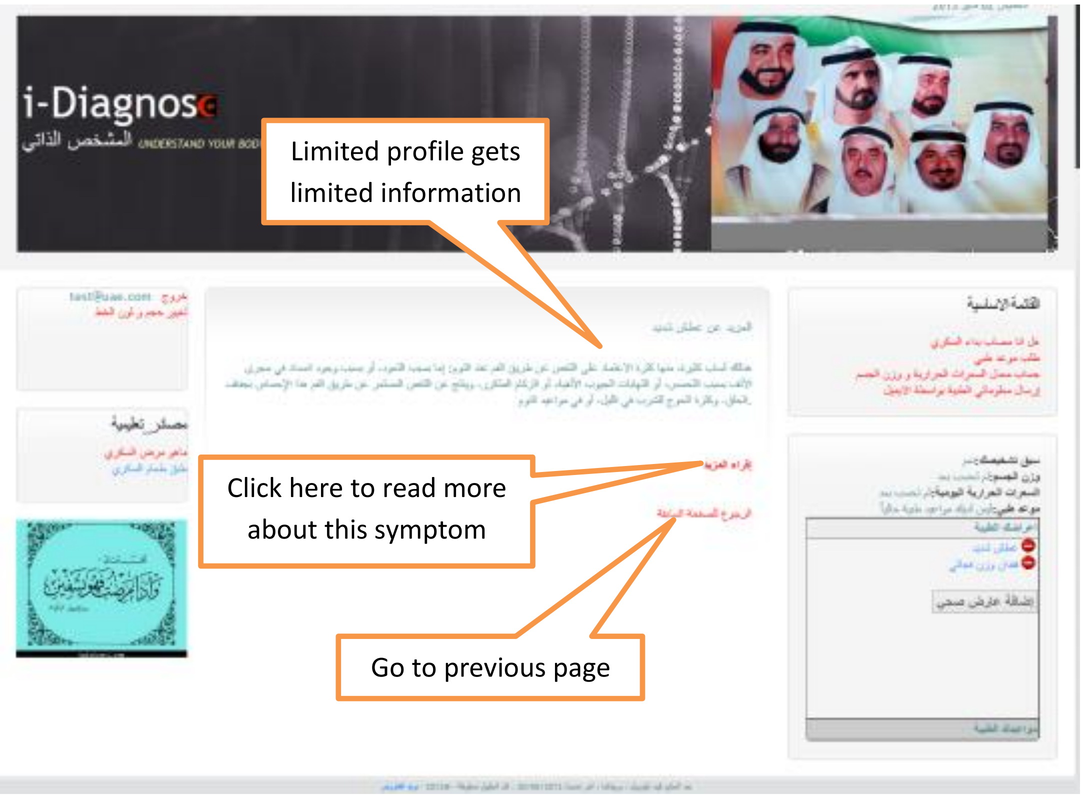
تنفيذ

Figure 84: Diagnostic result



Saeed clicked the first symptom to read more about it

Figure 85: Minimal information returned

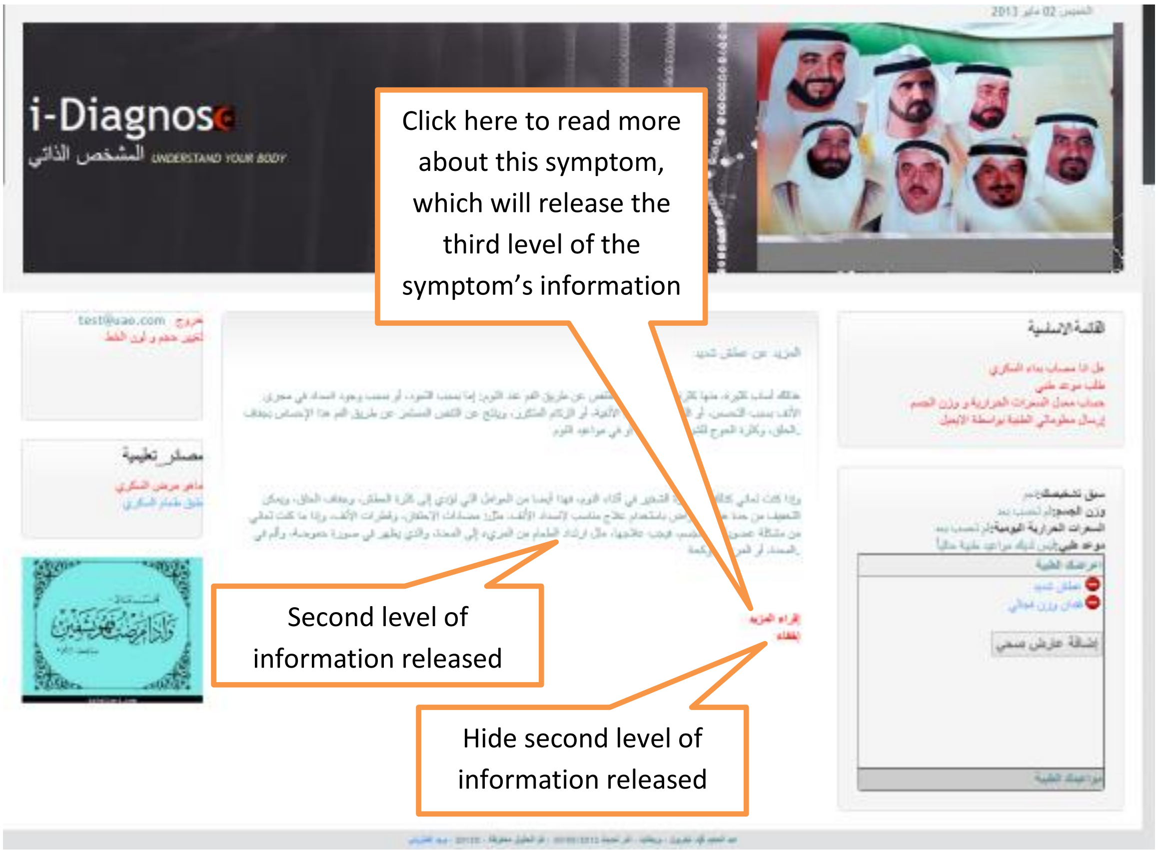


Limited profile gets limited information

Click here to read more about this symptom

Go to previous page

Figure 86: Read and Hide states

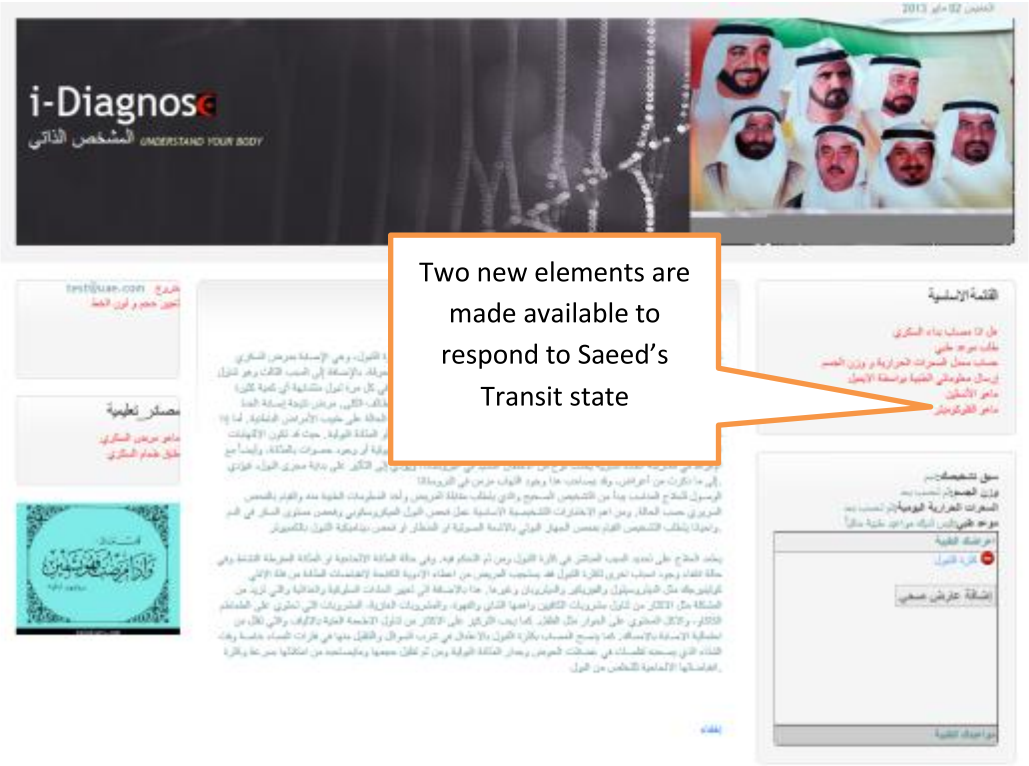


Click here to read more about this symptom, which will release the third level of the symptom's information

Second level of information released

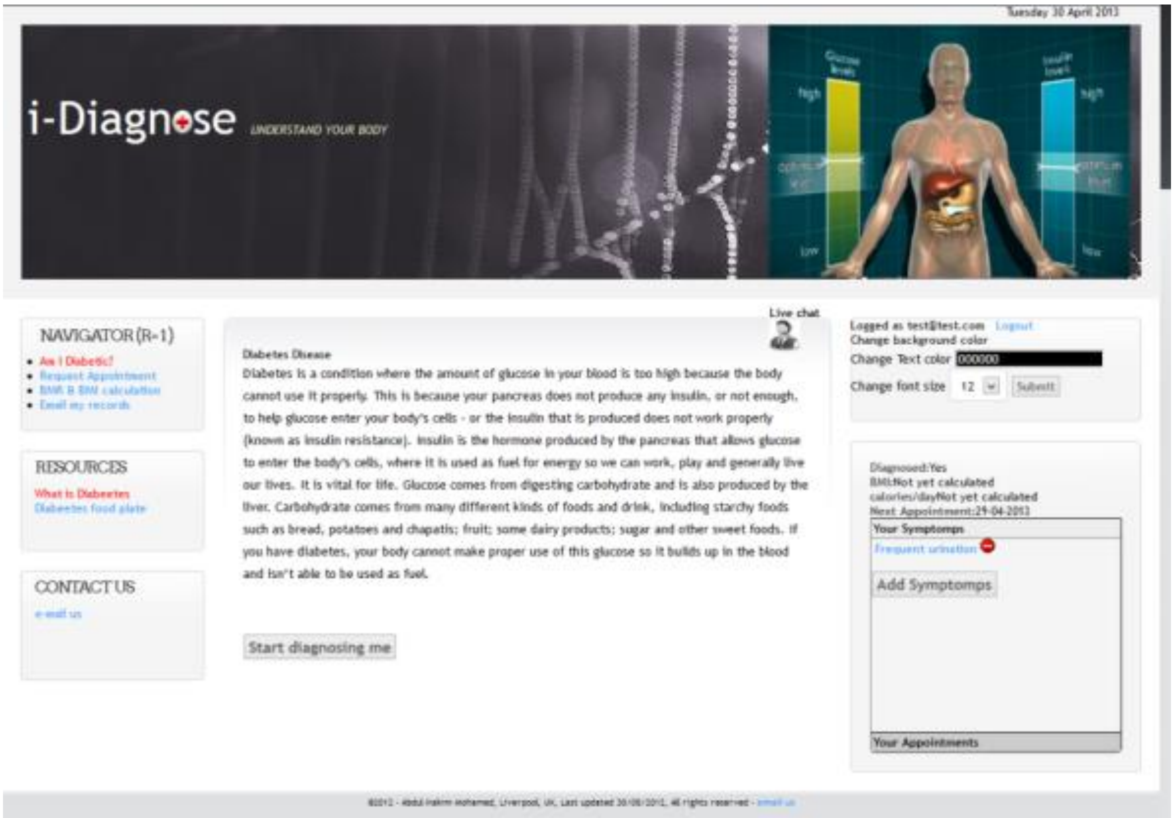
Hide second level of information released

Figure 87: Typical Arabic 'Transit' state profile interface



Two new elements are made available to respond to Saeed's Transit state

Figure 88: Typical English ‘Limited’ state profile interface



Diabetes Disease

Diabetes is a condition where the amount of glucose in your blood is too high because the body cannot use it properly. This is because your pancreas does not produce any insulin, or not enough, to help glucose enter your body's cells - or the insulin that is produced does not work properly (known as insulin resistance). Insulin is the hormone produced by the pancreas that allows glucose to enter the body's cells, where it is used as fuel for energy so we can work, play and generally live our lives. It is vital for life. Glucose comes from digesting carbohydrate and is also produced by the liver. Carbohydrate comes from many different kinds of foods and drink, including starchy foods such as bread, potatoes and chapatis; fruit; some dairy products; sugar and other sweet foods. If you have diabetes, your body cannot make proper use of this glucose so it builds up in the blood and isn't able to be used as fuel.

Logged as test@test.com
Change background color
Change Text color 000000
Change font size 12

Diagnosed:Yes
BMI:Not yet calculated
calories/day:Not yet calculated
Next Appointment:29-04-2013

Your Symptomps
Frequent urination

Your Appointments

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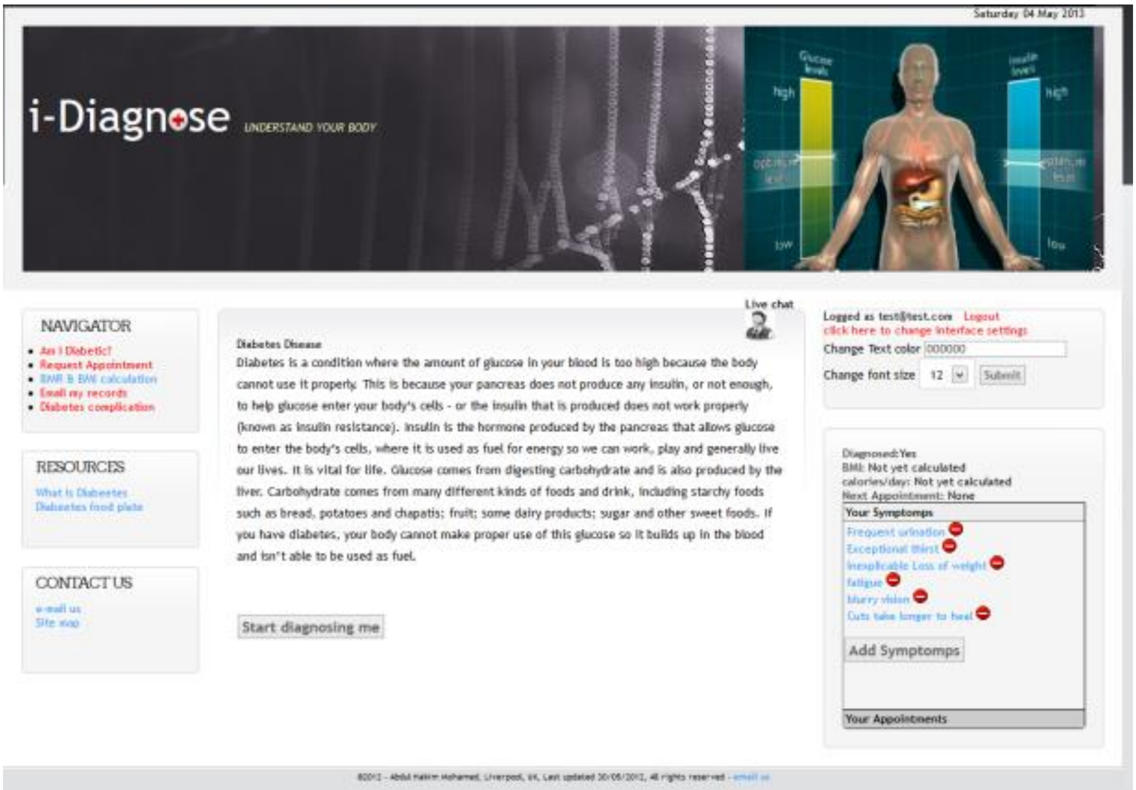
Figure 89: Typical English ‘Transit’ state profile interface



Diabetes Disease

Diabetes is a condition where the amount of glucose in your blood is too high because the body cannot use it properly. This is because your pancreas does not produce any insulin, or not enough, to help glucose enter your body's cells - or the insulin that is produced does not work properly (known as insulin resistance). Insulin is the hormone produced by the pancreas that allows glucose to enter the body's cells, where it is used as fuel for energy so we can work, play and generally live our lives. It is vital for life. Glucose comes from digesting carbohydrate and is also produced by the liver. Carbohydrate comes from many different kinds of foods and drink, including starchy foods such as bread, potatoes and chapatis; fruit; some dairy products; sugar and other sweet foods. If you have diabetes, your body cannot make proper use of this glucose so it builds up in the blood and isn't able to be used as fuel.

Logged as test@test.com
Change Text color 000000
Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: Not yet calculated
Next Appointment: None

Your Symptomps
Frequent urination
Exceptional thirst
Inexplicable Loss of weight
fatigue
blurry vision
Cuts take longer to heal

Your Appointments

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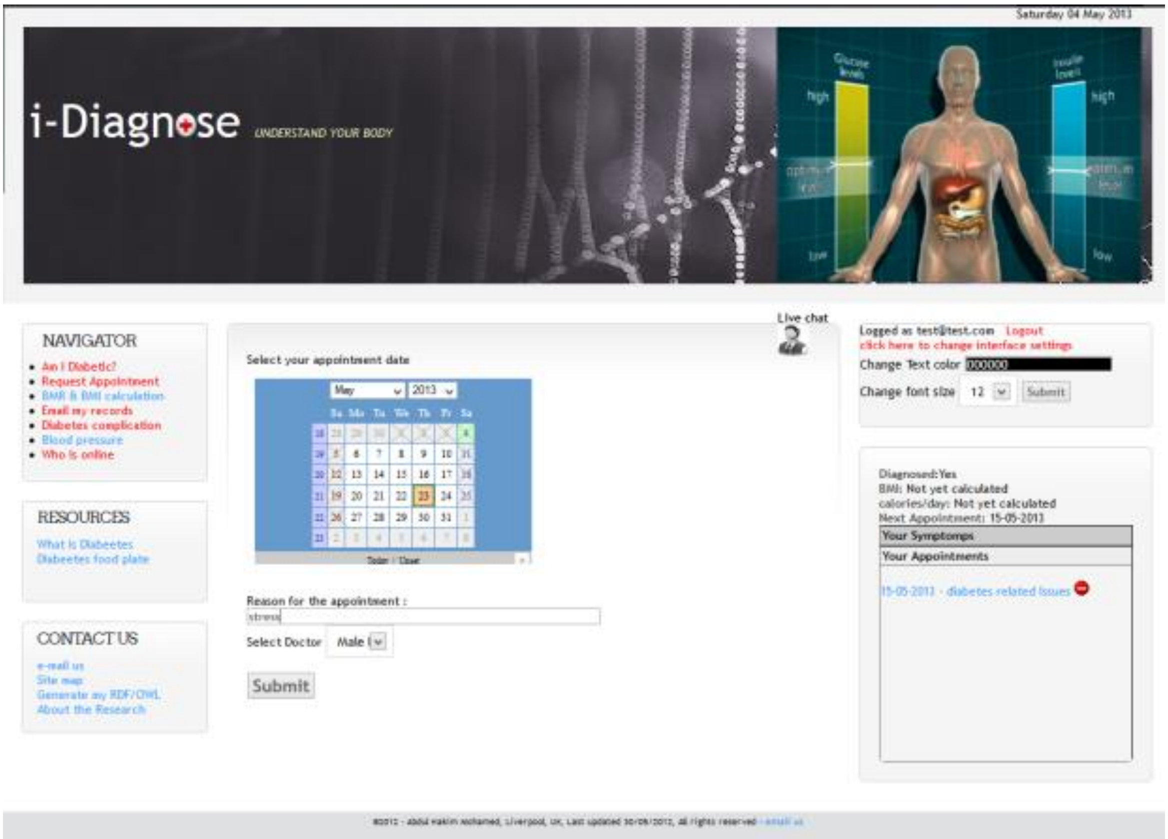
Figure 90: Request appointment



Select your appointment date

May 2013

Reason for the appointment : stress

Select Doctor Male

Logged as test@test.com

Change Text color 000000

Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: Not yet calculated
Next Appointment: 15-05-2013

Your Symptomps

Your Appointments

15-05-2013 - diabetes related issues

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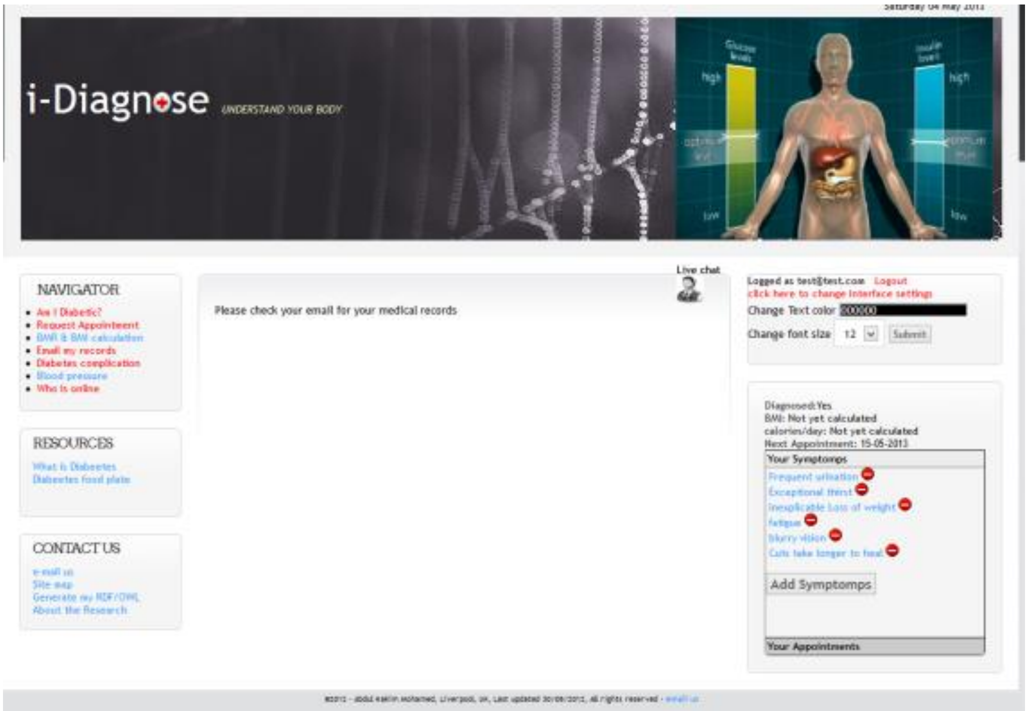
Figure 91: Emailing medical records



Please check your email for your medical records

Logged as test@test.com

Change Text color 000000

Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: Not yet calculated
Next Appointment: 15-05-2013

Your Symptomps

Frequent urination
Exceptional thirst
Inexplicable Loss of weight
fatigue
blurry vision
Cuts take longer to heal

Your Appointments

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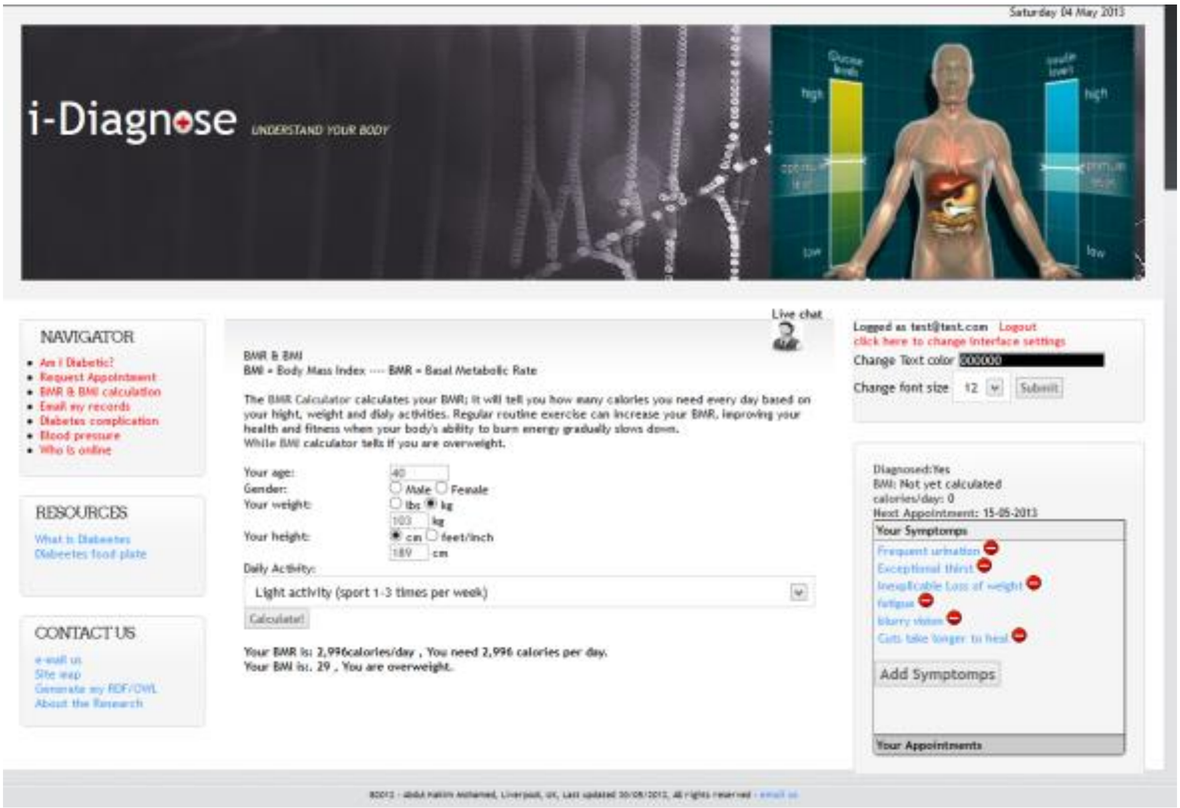
Figure 92: BMI and BMR calculations



BMR & BMI
BMI = Body Mass Index ---- BMR = Basal Metabolic Rate

The BMR Calculator calculates your BMR; it will tell you how many calories you need every day based on your hight, weight and dialy activities. Regular routine exercise can increase your BMR, improving your health and fitness when your body's ability to burn energy gradually slows down.
While BMI calculator tells if you are overweight.

Your age: 40
Gender: ○ Male ○ Female
Your weight: ○ lbs ● kg
103 kg
Your height: ● cm ○ feet/inch
189 cm
Daily Activity:
Light activity (sport 1-3 times per week)
Calculate!

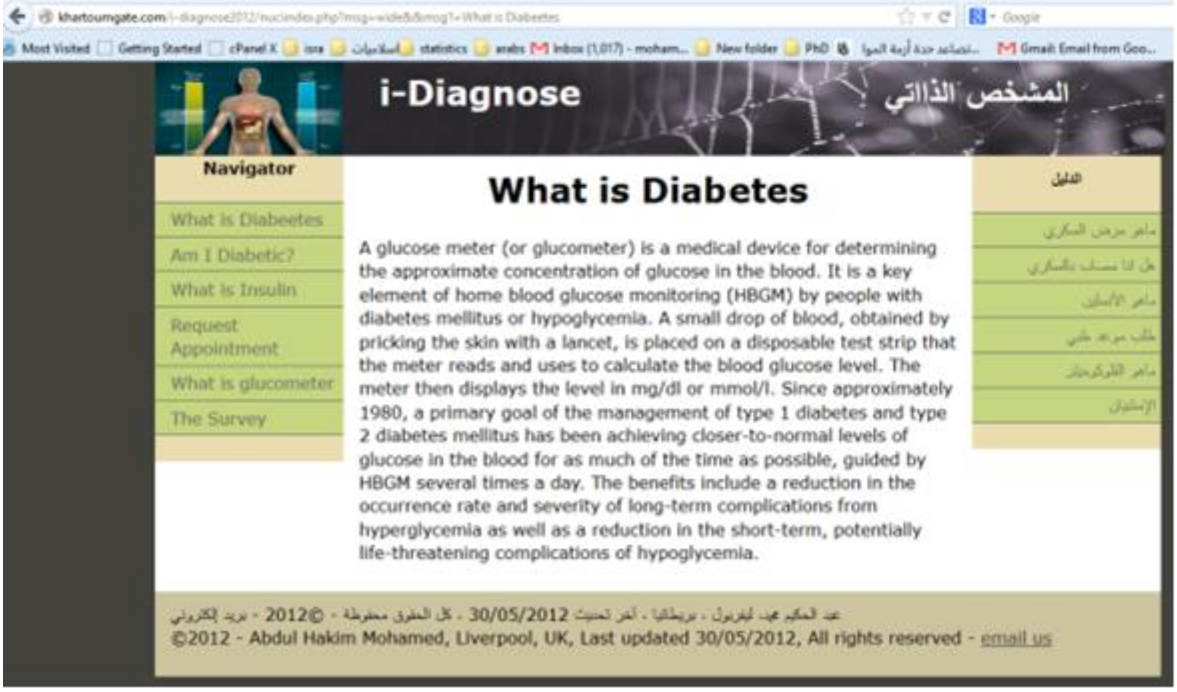
Your BMR is: 2,996calories/day , You need 2,996 calories per day.
Your BMI is:. 29 , You are overweight.

Logged as test@test.com
Change Text color 000000
Change font size 12

Diagnosed:Yes
BMI: Not yet calculated
calories/day: 0
Next Appointment: 15-05-2013

Your Symptomps
- Frequent urination
- Exceptional thirst
- Inexplicable Loss of weight
- fatigue
- blurry vision
- Cuts take longer to heal

Figure 93: NPCI English interface



What is Diabetes

A glucose meter (or glucometer) is a medical device for determining the approximate concentration of glucose in the blood. It is a key element of home blood glucose monitoring (HBGM) by people with diabetes mellitus or hypoglycemia. A small drop of blood, obtained by pricking the skin with a lancet, is placed on a disposable test strip that the meter reads and uses to calculate the blood glucose level. The meter then displays the level in mg/dl or mmol/l. Since approximately 1980, a primary goal of the management of type 1 diabetes and type 2 diabetes mellitus has been achieving closer-to-normal levels of glucose in the blood for as much of the time as possible, guided by HBGM several times a day. The benefits include a reduction in the occurrence rate and severity of long-term complications from hyperglycemia as well as a reduction in the short-term, potentially life-threatening complications of hypoglycemia.

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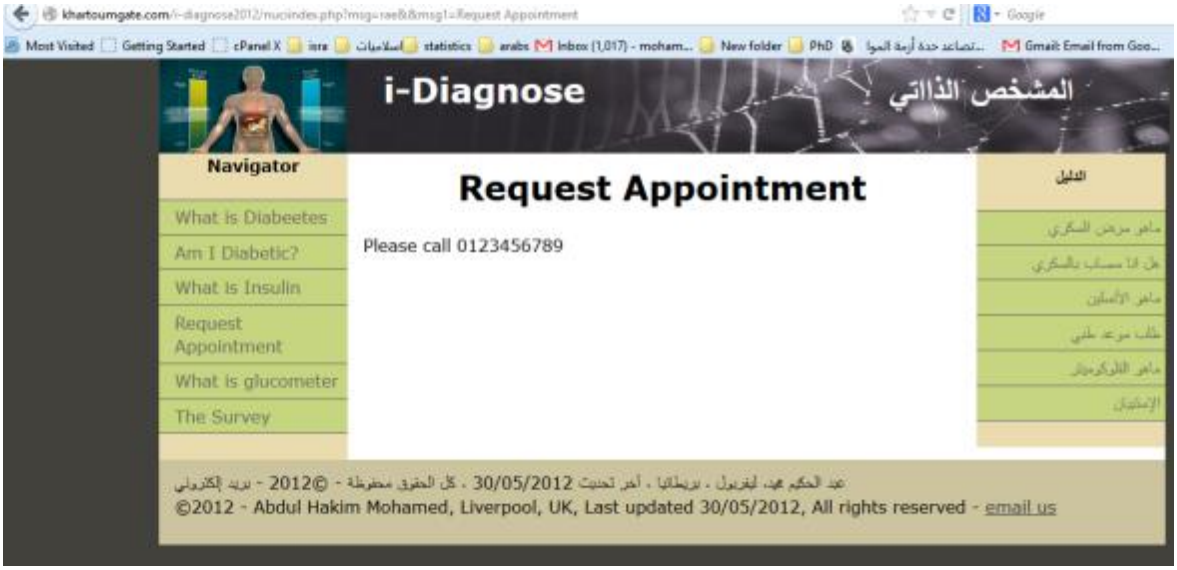
Figure 94 : NPCI English Interface for booking an appointment



Request Appointment

Please call 0123456789

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Figure 95: NPCI Arabic interface for booking an appointment

ماهو مرض السكري

السُّكَّري أو الداء السكري أو المرض السكري أو مرض السكر أو البوال السكري وغيرها هو متلازمة تتصف باضطراب الاستقلاب وارتفاع شاذ في تركيز سكر الدم الناجم عن عوز هرمون الأنسولين، أو انخفاض حساسية الأنسجة للأنسولين، أو كلا الأمرين. يؤدي السكري إلى مضاعفات خطيرة أو حتى الوفاة المبكرة، إلا أن مريض السكري يمكنه أن يتخذ خطوات معينة للسيطرة على المرض وخفض خطر حدوث المضاعفات. يعاني المصابون بالسكري من مشاكل تحويل الغذاء إلى طاقة (الاستقلاب). فبعد تناول وجبة الطعام، يتم تفكيكه إلى سكر يدعى: الغلوكوز ينقله الدم إلى جميع خلايا الجسم. وتحتاج أغلب خلايا الجسم إلى الأنسولين ليسمح بدخول الغلوكوز من الوسط بين الخلايا إلى داخل الخلايا. كنتيجة للإصابة بالسكري، لا يتم تحويل الغلوكوز إلى طاقة مما يؤدي إلى توفر كميات زائدة منه في الدم بينما تبقى الخلايا متعطشة للطاقة. ومع مرور السنين، تتطور حالة من فرط سكر الدم الأمر الذي يسبب أضراراً بالغة للأعصاب والأوعية الدموية. وبالتالي يمكن أن يؤدي ذلك إلى مضاعفات مثل أمراض القلب والسكتة وأمراض الكلى والعمى واعتلال الأعصاب السكري والتهابات اللثة، والقدم السكرية، بل ويمكن أن يصل الأمر إلى بتر الأعضاء. أما الأعراض التي توحي بهذا المرض: زيادة في عدد مرات التبول بسبب البوال (زيادة كمية البول) بسبب ارتفاع الضغط التناضحي، زيادة الإحساس بالعطش وينتج عنها زيادة تناول السوائل لمحاولة تعويض زيادة التبول، التعب الشديد والعام، فقدان الوزن رغم تناول الطعام بانتظام، شهية أكبر للطعام، تباطؤ شفاء الجروح، وتغيّم الرؤية. وتقل حدة هذه الأعراض إذا كان ارتفاع تركيز سكر الدم طفيفاً، أي إنه هناك تناسب طردي بين هذه الأعراض وسكر الدم.

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Figure 96: NPCI Arabic interface

طلب موعد طبي

إتصل على 0123456789

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Appendix C: Study questionnaires

A) e-HTAM Questionnaires

إستبيان حول قبول إستخدام الانترنت للحصول على الخدمات الطبية والصحية وتأثير الثقافة والعوامل التقنية على ذلك

السلام عليكم ،

أود إبلاغكم بأننا نجري حالياً دراسة علمية حول مفهوم أستخدام المواقع الإلكترونية للحصول على الخدمات الطبية والصحية من الانترنت ، من حجز مواعيد مع الطبيب أو الاستفسار عن بعض الاعراض الصحية.

نقوم أيضا بدراسة تأثير الثقافة والعادات والتقاليد الاجتماعية فى قبول مثل هذه الخدمات كبديل أو خيار موازي للذهاب للمستشفى أو زيارة الطبيب فى المركز الطبي.

إن نجاح الدراسة وتحقيق أهدافها متوقف على إجابتكم على هذا الاستبيان بشكل كامل كما ويود الباحث التأكيد على ان جميع المعلومات المقدمة ستعامل بسرية تامة كما أنكم لستم مطالبين بكتابة أسمائكم أو تحديد هوية أي مشارك منكم

سنكون ممتنين جدا لمشاركتكم في إنجاح هذا البحث من خلال تعبئة الاستبيان ٠ وفي حال وجود اي استفسار يتعلق بالاستبيان بصفة خاصة ، أو بالبحث بصفة عامة ، أرجو ألا تترددوا في الاتصال بنا عبر البريد الالكتروني على العنوان المذكور أدناة

عبد الحكيم محمد

Mohamed@hope.ac.uk

Abdul.Mohamed@liv.ac.uk

نشكركم شكراً جزيلاً لحسن تعاونكم معنا مقدماً

معلومات ديموغرافية:

الرجاء وضع أشارة X مقابل الاختيار المناسب

الجنس: ذكر☐ أنثى ☐

المؤهل التعليمي : دون الجامعي☐ دبلوم☐ جامعي☐ فوق الجامعي☐

العمر: أقل من 20☐ **من** 20 إلي 35☐ من 36 إلى 50☐ فوق 50☐

الجنسية: ____________________

إرشادات:

إن الجدول أدناة يحتوي مجموعة من من الاسئلة نرجوا منك ان تشير الى مدى موافقتك معتمدا في ذلك على درجة موافقتك.

لتوضيح كيفية الإجابه نورد المثال التالي:

	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
انا أفضل زيارة الطبيب والتحدث إليه وجهاً لوجه بدلا عن إستخدام الانترنت للتواصل أو التحدث للطبيب				√	

الرجاء وضع أشارة(√) مقابل كل سؤال من الأسئلة التالية حسب الخيارات المتاحة

	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
أفضل مواقع الصحة الالكترونية التي تتيح التحكم بالتصفح بسهولة					
أفضل مواقع الصحة الالكترونية الممتعة و المستساغة الاستخدام					
أفضل مواقع الانترنت التي توفر معلومات مفصلة عن المرض الذى أستفسر عنه ، بدلا عن مواقع توفر معلومات عامة					
أفضل إستخدام الوسائط المتعددة (صوت وصورة وحركة) لتقديم فكرة عن كيفية التعامل مع الخدمات الطبية المتوفرة على الانترنت بدلا من العيادة الطبية					
الحصول على الخدمات الطبية أو الصحية بواسطة الإنترنت يساعدني فى توفير الوقت والجهد					
أفضل مواقع الانترنت التي تمكنني من التحكم في طريقة عرض البيانات وتغيير اللون وحجم وشكل الخط بما يتلاءم وحاجتي					
سأقوم بإستخدام الانترنت لحجز مواعيد مع الطبيب متى ماكانت هذه الخدمة متوفرة					
سأقوم بإستخدام الانترنت للحصول على معلومات طبية					
أفضل زيارة مواقع الصحة الإلكترونية المشهورة والمتعارف عليها و الموثوق بها					
أفضل زيارة موقع صحة إلكتروني زرتة سابقا					
إنني أفضل التعامل مع المواقع الإلكترونية التي تركز على العلاقة التبادلية والتعاون					

	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
إنني أفضل إستخدام المواقع الإلكترونية التي لا تحتوى على الإيماءات العاطفيه					
أفضل مواقع الانترنت التى تمكنني من التفاعل مع الاخرين لمناقشة وضعي الصحي					
أفضل قراءة القليل و المفيد فقط عن المرض الذي أستفسر عنه					
أفضل إستحدام مواقع الصحة الالكنرونية المعقدة و التي تحتوي على كثير من الخصائص					
أفضل مواقع الصحة الالكنرونية التي تمكنني من التحكم في طريقة عرض البيانات بما يتلاءم وحاجتي					
أفضل مواقع الصحة الالكنرونية التي تتفاعل معي					
أفضل إستخدام مواقع الصحة الالكنرونية التي تتعامل مع الطلبات بسرعه					
طريقة وشكل تصميم واجهة التطبيق مهم لي					
الانترنت آمن وليس لدى أى مخاوف من سرقة بيناتي الشخصية والمالية فى حال طلب مني إدخالها فى مواقع الانترنت العامة					
المواقع الإلكترونية التى زرتها كانت معلوماتها مفيدة و مصدقة					
الأشخاص الذين يؤثرون على تصرفاتي يرون أنه يجب على إستخدام الإنترنت لاستخدام البرامج الصحية					

إذا كانت لديك تعليق أو ملاحظات أو إضافات الرجاء إضافتها بالأسفل:

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شكراً جزيلاً لحسن التعاون

A survey on the acceptance of the use of the Internet for medical and health services and the impact of culture and technical factors on it

Dear participant,

I would like to inform you that we are currently conducting a scientific study on the concept of using websites to get the medical and health services from the Internet, from booking appointments with the doctor, or to inquire about some health symptoms.

We are also studying the impact of the culture and the social customs and traditions in the acceptance of such services as an alternative or parallel option to go to the hospital or see a doctor at the medical centre.

The success of the study depends on your response to this questionnaire as fully as possible. The researcher would like to emphasise that all information provided will be treated confidentially and that you are not required to provide your name.

We would be very grateful for your participation in the success of this research through questionnaire. In case of any query regarding the questionnaire, in particular or research in general, please do not hesitate to contact us via e-mail to the address listed below:

Abdul Hakim Mohammed

Mohamed@hope.ac.uk

Abdul.Mohamed @ liv.ac.uk

Thank you very much for your cooperation with us in advance

Demographic information:

Please put an X against the appropriate choice

Gender: MALE ☐ FEMALE ☐

Educational Qualification: No university ☐ Diploma ☐ University graduate ☐

Age: Less than 20 ☐ 20 to 35 ☐ 36 to 50 ☐ over 50 ☐

Nationality: ______________________

The table below contains a set of questions, would you please indicate how much you agree, relying on the degree of consent.

The following example illustrate how to answer a question:

	Disagree strongly	Not OK	Neutral	OK	Strongly Agree
I better see a doctor and talk to him face to face instead of using the Internet to connect or talk to the doctor				√	

Please, mark (√) for each question from the following questions

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I prefer e-Health websites that are easy to navigate					
I prefer e-Health websites that are fun and enjoyable to use					
I prefer to use e-Health websites that provide detailed information about the disease which I inquire about, rather than general information					
I prefer the use of multimedia (voice, image, video) to learn about disease or other health issues than visiting the clinic					

Accessing medical or health services via the Internet helps me save time and effort					
I prefer to use e-Health websites that enable me to control the way the information is displayed and be able to personalise it to suit me					
I intend to use the Internet to book my medical appointment, if such service is available					
I intend to use the Internet to obtain health information					
I prefer to visit well known and trusted e-Health websites					
I prefer to visit an e-Health website that I have previously visited					
I prefer e-Health websites that are societal and focus on mutual relationships					
I prefer to use non-emotional e-Health websites					
I prefer e-Health websites that enable me to communicate with others to discuss my health concerns					
I prefer to read the minimum information about the disease I enquire about					
I prefer to use e-Health websites that have complex interface functionalities					
I prefer to use e-Health websites that that allow me to personalise the interface					
I prefer to use e-Health websites that communicate with me					
I prefer to use e-Health websites that serve my requests in a timely fashion/manner					
Feel and look (intuitiveness) of the website interface is important to me					
The Internet is safe I do not fear someone might misuse my personal information					
The contents of the e-health					

website I visited is relevant and credible					
People who influence my behaviours think that I should use online health services					

If you have any comments add them below:

Thank you very much for the good cooperation

B) i-Diagnose Questionnaires

إستبيان حول قبول إستخدام الانترنت للحصول على الخدمات الطبية والصحية وتأثير الثقافة والعوامل التقنية على ذلك

السلام عليكم ،

أود إبلاغكم بأننا نجري حالياً دراسة علمية حول مفهوم أستخدام المواقع الإلكترونية للحصول على الخدمات الطبية والصحية من الانترنت ، من حجز مواعيد مع الطبيب أو الاستفسار عن بعض الاعراض الصحية.

نقوم أيضا بدراسة تأثير الثقافة والعادات والتقاليد الاجتماعية فى قبول مثل هذه الخدمات كبديل أو خيار موازي للذهاب للمستشفى أو زيارة الطبيب فى المركز الطبي.

إن نجاح الدراسة وتحقيق أهدافها متوقف على إجابتكم على هذا الاستبيان بشكل كامل كما ويود الباحث التأكيد على ان جميع المعلومات المقدمة ستعامل بسرية تامة كما أنكم لستم مطالبين بكتابة أسمائكم أو تحديد هوية أي مشارك منكم

سنكون ممتنين جدا لمشاركتكم في إنجاح هذا البحث من خلال تعبئة الاستبيان ، وفي حال وجود اي استفسار يتعلق بالاستبيان بصفة خاصة ، أو بالبحث بصفة عامة ، أرجو ألا تترددوا في الاتصال بنا عبر البريد الالكتروني على العنوان المذكور أدناة

عبد الحكيم محمد

Mohamed@hope.ac.uk

Abdul.Mohamed@liv.ac.uk

نشكركم شكراً جزيلاً لحسن تعاونكم معنا مقدماً

معلومات ديموغرافية:

الرجاء وضع أشارة X مقابل الاختيار المناسب

الجنس: ذكر☐ أنثى ☐

المؤهل التعليمي : دون الجامعي☐ دبلوم☐ جامعي☐ فوق الجامعي☐

العمر: أقل من 20☐ من 20 إلي 35☐ من 36 إلى 50☐ فوق 50☐

الجنسية: ______________________

إرشادات:

إن الجدول أدناة يحتوي مجموعة من من الاسئلة نرجوا منك ان تشير الى مدى موافقتك معتمدا في ذلك على درجة موافقتك.

لتوضيح كيفية الإجابه نورد المثال التالي:

	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
انا أفضل زيارة الطبيب والتحدث إليه وجهاً لوجه بدلا عن إستخدام الانترنت للتواصل أو التحدث للطبيب				√	

الرجاء وضع أشارة(√) مقابل كل سؤال من الأسئلة التالية حسب الخيارات المتاحة

	غير موافق بشدة	غير موافق	محايد	موافق	موافق بشدة
المعلومات الصحية فى هذا البرنامج تبدومناسبه و منطقية					
نظام تصفح هذا البرنامج معقولة ومناسبة لي					
واجهة هذا البرنامج مناسبة لي لاني أستطيع التجكم فيها و التصفح بسهولة					
أنا لست قلقاً لإرتكابي أخطاء أثناء إستخدامي لهذا البرنامج					
سأستعين بأصدقائي ليساعدوني اذا واجهتني مشكلة في إستخدام هذا البرنامج					
لا مانع لدي في أن أشارك أهلي و أصدقائي مواعيدي و بياناتي الطبية					
خاصية التشخيص الذاتي الموجودة فى هذا البرنامج جعلتني أفكر بصورة إيجابية حول مفهوم الخدمات الصحية عبر الانترنت					
هذا البرنامج يمكن أن تكون بديل مناسب لزيارة الطبيب شخصياً					
هذا البرنامج آمن وليس لدى أى مخاوف من سرقة بياناتي الشخصية					
الأشخاص المهمين بالنسبه إلي يرون أنه يجب علي إستخدام برامج الانترنت التي المخصصة للاغراض الصحبة					

يمكنني تشخيص نفسي بسهولة بإستخدام هذا البرامج					
المعلومات الصحية فى هذا البرنامج مفيدة					
هذا البرنامج ساعدني فى فهم ومعرفةبعض مايتعلق بمرض السكري					
سأقوم بإستخدام هذا البرنامج أو برامج شبيه لتشخيص أعراضي الصحية أو حجز موعد طبي					
هذا البرنامج يتذكر من أنا ، ويقدم المعلومات بصورة مفصلة ومخصصة لي					
خاصية التفاعل الموجودة فى هذا البرنامج مفيدة					
هذا البرنامج يقدم المساعدة حينما تواجهني مشكلة أثناء إستخدامه					
هذا البرنامج يقوم بتنفيذ الاوامر بسرعة مقبولة					

إذا كانت لديك تعليق أو ملاحظات أو إضافات الرجاء إضافتها بالأسفل:

شكراً جزيلاً لحسن التعاون

A survey on the acceptance of the use of the Internet for medical and health services and the impact of culture and technical factors on it

Dear participant,

I would like to inform you that we are currently conducting a scientific study on the concept of using websites to get the medical and health services from the Internet, from booking appointments with the doctor, or to inquire about some health symptoms.

We are also studying the impact of the culture and the social customs and traditions in the acceptance of such services as an alternative or parallel option to go to the hospital or see a doctor at the medical centre.

The success of the study depends on your response to this questionnaire as fully as possible. The researcher would like to emphasise that all information provided will be treated confidentially and that you are not required to provide your name.

We would be very grateful for your participation in the success of this research through questionnaire. In case of any query regarding the questionnaire, in particular or research in general, please do not hesitate to contact us via e-mail to the address listed below

Abdul Hakim Mohammed

Mohamed@hope.ac.uk or Abdul.Mohamed @ liv.ac.uk

Thank you very much for your cooperation with us in advance

Demographic information:

Please put an X against the appropriate choice

Gender: MALE ☐ FEMALE ☐

Educational Qualification: No university □ Diploma □ University graduate □

Age: Less than 20 □ 20 to 35 □ 36 to 50 □ over 50 □

Nationality: ______________________

The table below contains a set of questions, would you please indicate how much you agree, relying on the degree of consent.

The following example illustrate how to answer a question:

	Disagree strongly	Not OK	Neutral	OK	Strongly Agree
I better see a doctor and talk to him face to face instead of using the Internet to connect or talk to the doctor				√	

Please, mark (√) for each question from the following questions

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The information provided by i-Diagnose is adequate and suitable for me					
The i-Diagnose navigation system is adequate and suitable for me.					
The i-Diagnose interface is appropriate for me, as I can control and explore it easily					
I'm not worried about making mistakes while interacting with i-Diagnose					
I will ask my friends for help if I have any issues while using i-Diagnose.					
I would be willing to share my appointments and health records with my friends and family.					
i-Diagnose self-diagnostic features helped me form a positive attitude towards online health services.					

i-Diagnose can be a relatively acceptable alternative to speaking with a doctor face to face to check my symptoms.					
i-Diagnose is safe and I do not fear that my personal data may be stolen or misused.					
People who influence my behaviour think that I should use e-Health web-based services.					
I can easily diagnose myself through i-Diagnose					
Information provided by i-Diagnose is useful.					
i-Diagnose helped me understand more about diabetes.					
I intend to use i-Diagnose (or similar online tools) to check my symptoms or book an appointment.					
i-Diagnose knows who I am, and provides a tailored screen to suit me					
i-Diagnose interactivity features were useful.					
i-Diagnose provides an explanation whenever I can’t access elements in the interface.					
When I click on an option i-Diagnose returns the result quickly (the response rate is acceptable).					

If you have any comments add them below:

Thank you very much for the good cooperation

والحمد لله رب العالمين

All thanks to almighty Allah (SWT) for giving the strength and the courage to complete this research