ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

A USER RESEARCH FOR A MEDICAL DEVICE BASED ON UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

M.Sc. THESIS

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Department of Industrial Design

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Thesis Advisor: Assoc. Prof. Dr. Şebnem TİMUR ÖĞÜT

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

BİR MEDİKAL CİHAZ ÜZERİNE BİRLEŞTİRİLMİŞ TEKNOLOJİ KABUL VE KULLANIM TEORİSİ TEMELLİ KULLANICI ARAŞTIRMASI

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OCAK 2015

Canan Kurtuluş, a **M.Sc.** student of ITU **Graduate School of Industrial Design** student ID 502101903, successfully defended the **thesis** entitled "**A USER RESEARCH FOR A MEDICAL DEVICE BASED ON UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY**", which he/she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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Date of Submission : 12 December 2014
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To my spouse and my son,

FOREWORD

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ABBREVIATIONS

AAP : American Academy of Pediatrics
DTPB : Decomposed Theory of Planned Behavior
FDA : US Food and Drug Administration
IDT : Innovation Diffusion Theory
ICH : International Conference on Harmonisation
ISO : International Organization for Standardization
ITU : Istanbul Technical University
MM : Motivational Model
MPCU : Model of Personal Computer Utilization
OTA : The Office of Technology Assessment
SCT : Social Cognitive Theory
SOBE : Sarılık Ölçüm ve Belirleme
TAM : Technology Acceptance Model
TPB : Theory of Planned Behavior
TRA : Theory of Reasoned Action
TÜBİTAK : The Scientific and Technological Research Council of Turkey
UTAUT : Unified Theory of Acceptance and Use of Technology

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A USER RESEARCH FOR A MEDICAL DEVICE BASED ON UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

SUMMARY

How and why people accept new technologies and products. Academics and scholars try to explain this complex interplay between people and technology. Technology acceptance studies try to explain the factors that return acceptance of new technology and products.

Hereby, this study makes a user research for a medical device based on Unified Theory of Acceptance and Use of Technology (UTAUT) for analyzing the factors that influence new product acceptance in medical context. In order to clarify product acceptance phenomenon in medical context, medical technologies and human product interaction will be examined.

In this study, observation, interview and questionnaire research methods are utilized. This study starts with the introduction of a new hand-held transcutaneous bilirubin assessment device to 20 participants who are doctors, nurses and medical officer. This phase aims to get very first ideas and usage experiences of users. After the introduction phase, a small un-structured interview is done with each of the users. During the interview, users' positive and negative ideas are noted down. Finally, questionnaire is administrated to all users.

The questionnaire consists of five sections. First section tries to collect demographic information, second section tries to analyze medical device background of users, third section consist of five point likert scale UTAUT questions, fourth section includes keywords that can identify sample product according to users and fifth and the last part questions the general ideas about the product. The main part of questionnaire is UTAUT questions that are used to understand factors of new product acceptance.

The interview questions and questionnaire are mainly based on UTAUT in order to understand user behavior in medical context. The results are used to predict the factors that affect acceptance of sample product, namely SOBE.

In conclusion, this study aims to collect information about the factors that influence new product acceptance in health care. Findings serve both medical sector and product acceptance model studies that try to clarify acceptance phenomenon in health context.

BİR MEDİKAL CİHAZ ÜZERİNE BİRLEŞTİRİLMİŞ TEKNOLOJİ KABUL VE KULLANIM TEORİSİ TEMELLİ KULLANICI ARAŞTIRMASI

ÖZET

Kullanıcıların yeni teknoloji ve ürünleri nasıl ve neden kabul ettikleri merak konusu olmuştur. Yeniliklerin yayılımı, yeni ürün ve teknolojilerin kabul edilip kullanılması ya da kullanılmayıp reddedilmesi pazar araştırmacılarının ilgi odağı olmuştur. Bu çalışmalar firma sahiplerinin ve yetkililerinin de ilgilerini çekmiş ve ürünlerinin kullanıcılar tarafından kabul edilip kullanılması için daha etkin ve başarılı yöntem arayışlarına girmişlerdir.

Kullanıcı davranışlarını incelemek, pazar araştırmacıları için önemli bir metod olmuştur. Kullanıcı davranışlarını ürün kabulü bağlamında etkileyen faktörler, ürünün gerçek hayatta kullanılıp kullanılmayacağını öngörmek amacıyla araştırmacılar tarafından tahmin edilmeye çalışılmaktadır. Teknoloji kabulü araştırmaları da, kabul ya da red ile sonuçlanan durumları, buna sebep olan faktörleri modellemeye çalışmaktadırlar.

Bu çalışma, Birleştirilmiş Teknoloji Kabul ve Kullanım Modeli (UTAUT) temelli kullanıcı araştırması yaparak kullanıcı davranışlarını etkileyen faktörleri medikal cihazlar üzerinden analiz etmeyi hedeflemektedir. Ürün kabulünü sağlık sektörü bağlamında anlamaya çalışan bu çalışmada, ürün kabul fenomeni, ürün kabul modelleri, kullanılabilirlik, medikal cihaz ve teknolojiler ve insan-ürün etkileşimi konuları araştırılmıştır.

Medikal sektör, teknolojik gelişmeleri yakından izleyen, izlemesi gereken bir sektördür. Bu nedenle her geçen gün, yeni bir medikal cihaz, yeni bir teknolojik gelişme ile karşı karşıyayız. Ancak, bu ürünlerin personel tarafından kabul edilip edilmeyeceğini tahmin etmek güçtür. Özellikle bilgi teknolojileri firmaları bu belirsizliği aralamak, yatırımlarını doğru yapmak, başarısız olmamak için teknoloji/ürün kabulü araştırmalarına gittikçe daha fazla önem vermektedirler.

Medikal teknolojiler, devlet politikası olarak desteklenen, üzerinde çalışılması gerektiği düşünülen ve milli cihazlarının geliştirilmesi gereken bir alan olarak değerlendirilmektedir. Bu nedenle, Türkiye Bilimsel ve Teknolojik Araştırma Kurumu (TÜBİTAK) bünyesinde medikal cihaz geliştirmek için proje başlatılmıştır. Çeşitli cihazların geliştirildiği bu projenin bir parçası da "yenidoğanda transkutan bilirubin el ölçüm cihazı"nın araştırma ve geliştirme çalışmalarını kapsamaktadır.

Bu tez, Birleştirilmiş Teknoloji Kabul ve Kullanım Modeli temelli bir kullanıcı araştırması yapmak amacıyla hazırlanmıştır. Bu araştırma için de örnek ürün olarak TÜBİTAK bünyesinde geliştirilen medikal el cihazı seçilmiştir. Henüz araştırma geliştirme safhasında olan bir ürün ve teknoloji için elde edilecek veriler ürünün geliştirilmesine katkı sağlayacaktır.

Tezin ilk bölümü, tezin amacını, hangi anahtar kelimelerle literature taraması yapıldığını ve tezin yapısını açıklamaktadır.

Tezin ikinci bölümünde, teknoloji kabulü fenomeninin ne olduğu, yeni teknoloji ve ürün karşısında tüketici davranışlarını tahmin etmek için zaman içinde gelişen teori ve modeler anlatılmaktadır. İkinci bölümde, teknoloji kabul modellerini kullanan çalışmalardan örnekler verilmiştir.

Tezin üçüncü bölümünde, kullanılabilirlik kavramı tanımlanmış, ürün kabulü ve kullanılabilirlik arasındaki ilişkiyi açıklamaya çalışan araştırmalara yer verilmilştir.

Tezin dördüncü bölümünde, medikal cihaz ve pediatrik medikal cihaz tanımları yapılmış, yenidoğanda bilirubin ölçümü yapan medikal teknolojiler tanıtılmış, tasarım ve medikal ürünler arasındaki ilişkiye yer verilmiştir. Bölüm sonunda da, medikal cihazlar üzerinde yapılan ürün kabul modeli çalışmaları örneklendirilmiştir.

Tezin beşinci bölümünde, tezin araştırma yöntemi detaylandırılmıştır. Araştırmada, hem yapılandırılmamış mülakat hem de anket yöntemleri kullanılmıştır. Kullanılan araştırma yöntemlerinde, UTAUT soru içerikleri ve yapıları temel alınmıştır.

Araştırma yeri olarak iki lokasyon belirlenmiştir. Bunlardan biri Kartal Eğitim Araştırma Hastanesi, yenidoğan bölümü, diğeri ise TÜBİTAK sağlık birimidir. Araştırma konusunun hassasiyeti ve gerekliliği itibariyle Kartal Eğitim Araştırma Hastanesi etik kurulundan izin alınmış, araştırma öncesinde hastane yönetimine gerekli bilgi verilmiştir.

Araştırmanın ilk kısmında, doktor, hemşire ve sağlık memurundan oluşan 20 sağlık personeline araştırma konusu olan transkutan el cihazı kısaca tanıtılmış ve kullanıcıların bu ürünü serbest bir şekilde 2-3 dakika kullanmaları, keşfetmeleri istenmiştir. Kullanıcıların ürünle etkileşimleri gözlemlenmiş, ürünle ilgili soruları cevaplanmış, yapılan her yorum not alınmıştır.

Araştırmanın ikinci kısmında, her kullanıcı ile yapılandırılmamış mülakatlar yapılmıştır. Mülakatlar esnasında araştırma yapılan ürün ortamda tutulmuş, kullanıcının kullanmasına, ürün hakkında fikirler öne sürmesine olanak sağlanmıştır. Her kullanıcının tepkisi, soruları, talepleri farklı oluğundan yapılandırılmamış mülakatlar gerçekleştirilmiştir. Ama genel olarak, kullanıcıların, ürünle ilgili yorumları, ürünün kullanıcı tarafından düşünülen pozitif veya negatif özellikleri, başka ürünlerle karşılaştırıp değerlendirme yapmaları istenmiştir. Kullanıcı düşünceleri, not alınarak kayda geçirilmiştir.

Araştırmanın son kısmında ise, katılımcıların 5 bölümden oluşan bir anket doldurması istenmiştir. Anketin ilk bölümü, kullanıcıların yaş, cinsiyet, meslek ve öğrenim bilgilerini toplamayı hedeflemektedir. İkinci bölüm, katılımcıların medikal cihaz kullanımlarını, önceki tecrübelerini ve eğer var ise transkutan cihazı deneyimlerini anlamaya çalışmaktadır. Anketin üçüncü bölümü, son geliştirilen ürün kabul modellerinden biri olan Teknoloji Kabulü ve Kullanımı Birleşik Teorisi (UTAUT) sorularını içermektedir. Üçüncü bölümdeki bu 34 soru, 5'li likert ölçeğine göre derecelendirilmiştir. 1 "Kesinlikle katılmıyorum", 2 "Katılmıyorum", 3 "Kararsızım", 4 "Katılıyorum", 5 "Kesinlikle katılıyorum" u ifade etmektedir. Katılımcıların, verilen 34 farklı madde ile ilgili fikirlerini bu derecelendirmeye göre ifade etmeleri istenmiştir. Anketin dördüncü kısmında, kullanıcıların tanıtılan yeni ürünle ilgili düşünceleri, verilen anahtar kelimeleri seçmeleri yoluyla elde edilmeye çalışılmaktadır. Beşinci ve son kısım ise açık uçlu bir soru olup, katılımcıların ürünle, ürün kullanımı ile ilgili genel görüşlerini elde etmeyi amaçlamaktadır.

Tezin altıncı bölümünde, araştırmalarla elde edilen veriler analiz edilmiş, sonuçlar elde edilmiştir. Araştırma sonuçları ayrı ayrı detaylandırılmıştır. İlk bölümde gözlem ve görüşmelerde alınan notlar detaylandırılmış, UTAUT ile ilişkilendirerek yorumlanmaya çalışılmıştır. İkinci bölümde ise, anket sonuçları verilmiştir. Anket içeriğindeki her soru grubu kendi arasında değerlendirilmiş, sonuçlar grafikler yardımıyla görselleştirilmiştir. Bölüm sonunda, araştırmada kullanılan ürün kabul modelinin medikal sektör bağlamında değerlendirmesi ve tartışması yapılmıştır.

Tezin yedinci bölümü sonuç bölümüdür. Araştırma sonuçları özetlenmiş, çalışmada yaşanan kısıtlar değerlendirilmiştir ve gelecek çalışmalar için tavsiyelerde bulunulmuştur.

Son olarak, bu tez, bir kullanıcı araştırması yaparak medikal alanda geliştirilen bir ürünün kabulünü etkileyen faktörleri analiz etmeyi amaçlamaktadır. Bu nedenle, sonuçları itibariyle, hem medikal sektöre, hem de özellikle medikal sektörün sorularını cevaplayacak ürün kabul modeli oluşturacak çalışmalara katkı sağlamayı hedeflemektedir.

1. INTRODUCTION

This chapter covers purpose of the thesis, scanned literature review and keywords and finally the structure of the thesis. These will be explained respectively in the following sections.

1.1 Purpose of Thesis

One of the most notable and well-established streams of research in Information Systems (IS) is how and why people adopt information technology. The need to investigate the factors influencing successful acceptance arises due to the complex interplay between people and technology. Technology acceptance research, therefore, seeks to clarify the factors that contribute to the success and failure of information systems and technologies (Wills, El-Gayar and Bennett, 2008).

Consumer population is increasing steadily and for this reason developing technology challenge producers to be distinctive in order to survive in a competitive market. Consumer research and user analysis are used to predict probable rejection or acceptance to risky product investments. For this reason, user-centered design is gaining importance by research and development (R&D) departments of the companies.

The purpose of this thesis is to make contribution to research and development studies about medical products at TÜBİTAK by analyzing the factors that influence user behavior which return acceptance of new products. In order to achieve this, health technologies and human product interaction should be examined. Consequently, the main research question of this study is:

- What are the factors influencing user acceptance of new medical products in medical context?

1.2 Literature Review

This thesis benefits from sociology, psychology, industrial design, information technology, health technologies and management literature. A broad variety of keywords including; product/technology acceptance, innovation, information technology, TAM, UTAUT, usability, medical products, medical products design, health technologies, products appearance and product experience are scanned at ITU, TÜBİTAK Libraries and various electronic databases.

In the light of literature review, product acceptance phenomenon has been tried to understand

1.3 Structure of the Thesis

The thesis is constituted of seven chapters and it can be followed as below:

Chapter 1 presents purpose of the thesis, reviewed literature and keywords and finally structure of the study.

Chapter 2 defines technology acceptance phenomenon. Later on, theories and models that try to predict consumer behavior towards new products are detailed. Then, studies that used technology acceptance model as a research model are summarized.

In the Chapter 3, as an essential feature of products, usability is defined and analyzed as a dimension of acceptance.

Chapter 4 gives an insight to medical devices. Medical technologies and new medical products, which are related to this study, are presented. Moreover, technology acceptance studies that focus on acceptance phenomenon are analyzed.

Chapter 5 presents methodology of the study. It supports theoretical discussion by a survey. After defining the objectives and exploring the overall design of the study, the procedure of the study is described.

In the chapter 6, responses of the participants are analyzed in detail; results of the study are discussed in relation with the findings of the literature review study.

The last chapter presents a brief summary of the thesis and the findings of the survey. Limitations are described and the thesis is concluded with the implications for further research.

2. TECHNOLOGY ACCEPTANCE

Before examining the theories and models related with the thesis subject, chapter begins with definition of the *technology acceptance*. Then, theories and models which are both related to consumer behavior and user acceptance are explored. The last section of the chapter will summarize studies that used technology acceptance model as a research model.

2.1 Technology Acceptance

Technology acceptance is defined as an individual's psychological state with regard to his or her voluntary or intended use of a particular technology (Gattiker 1984). In support of Davis' (1989, p.320) the acceptance and use of technology has received attention from information technology researchers and practitioners (e.g., Wand and Yang, 2005; Wu et al., 2007; Carlsson et al., 2006; Wong et al., 2013). Researchers and practitioners focus on how individual human and social behavior impacts theories and models of technology acceptance. Technology acceptance research has been profoundly impacted by the theories of individual human and social behavior emerging from the disciplines of psychology and sociology.

2.2 Technology Acceptance Theories and Models

This part of the study presents the theories and models developed in different disciplines and used in predicting, explaining, and understanding individuals' acceptance of new products or technologies.

These models have evolved over the years and came as a result of persistent efforts of models' validation and extension that took place during the period each was presented. For example, psychology contributed the Theory of Reasoned Action, TRA (Fishbein and Ajzen, 1975), which was extended to the Theory of Planned Behaviour, TPB (Ajzen, 1991), which also had an extension, the Decomposed Theory of Planned Behaviour, DTPB (Taylor and Todd, 1995); Information Systems

contributed the Technology Acceptance Model, TAM (Davis, 1986), which is an extension of Theory of Reasoned Action; yet also has an extension TAM2 (Venkatesh and Davis, 2000) and the Unified Theory of Acceptance and Use of Technology, UTAUT (Venkatesh et al., 2003). UTAUT is the unified model which is a combination of other models including the aforementioned in addition to Rogers' Diffusion of innovations, DOI (1983), Bandura's Social Cognitive Theory, SCT (1989), Vallerand's Motivational Model (1997), MM (1985), and Triandis' Model of PC Utilization, MPCU (1979) (Venkatesh et al., 2003).

2.2.1 Theory of reasoned action

Theory of Reasoned Action (TRA) of Martin Fishbein and Icek Ajzen (1975) is one of the most fundamental and influential theories of human behavior. Moreover, it is the earliest model used to explain technology acceptance. It is drawn from social psychology and a wide range of behaviors has been predicted by application of TRA. Figure 2.1 shows the general outline of TRA.

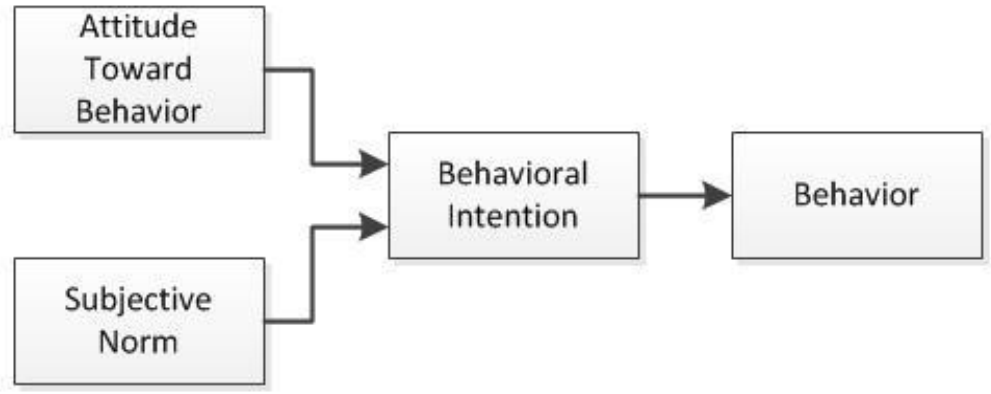

Figure 2.1 : The Theory of Reasoned Action (Fishbein and Ajzen, 1975)

The theory looks at behavioural intentions, as the main predictor of behaviour. According to TRA, the most important determinant of an individual's behaviour is behavioural intentions. An individual's intention to perform behaviour is a combination of:

- Attitude towards performance of the behaviour: refers to the sum of one's beliefs about performing the target behavior, which can be positive or negative. Ajzen and Fishbein states that a person is more intent to perform a behavior when he/she has a positive attitude toward a behavior, and he/she is less intent to perform when he/she has a negative attitude (Fishbein and Ajzen, 1975).

- Subjective norms: is a person's perception of others' belief about whether she or he should perform a behavior. According to TRA, the more a person belief that the others who are important to him/her, the more he/she intends to perform so (Fishbein and Ajzen, 1975).

Ajzen had taken the relationships between personality traits, behavior and attitude into consideration while he was developing TRA. The theory assumes that behavior is under volitional control. This is the greatest limitation of TRA that it can be applied to that is consciously thought.

2.2.2 Theory of planned behavior

Theory of planned behaviour (TPB) is proposed by Ajzen because of the limitations of the theory of reasoned action. TPB is an extension of the theory of reasoned action, and as its predecessor, the central factor of the TPB is the individual's intention to perform a given behaviour. As in the Figure 2.2, the model posits that behavioral intention is a function of, in addition to attitude, subjective norm and perceived behavioral control.

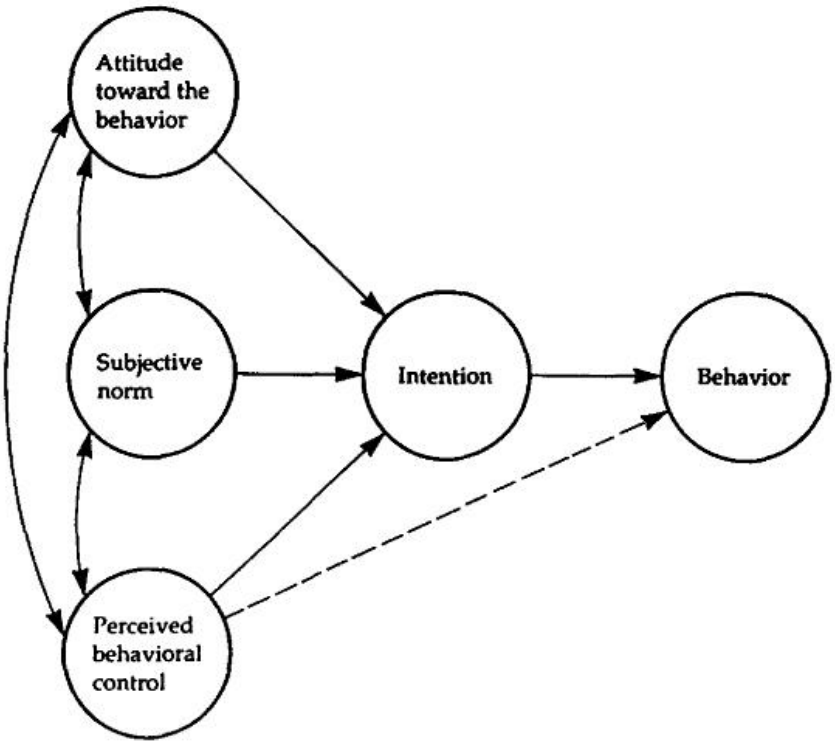

Figure 2.2 : Theory of Planned Behavior (Ajzen, 1991)

Ajzen thought that under some circumstances, behaviors are considered more involuntary. For this reason, Ajzen proposed Theory of Planned Behavior model and added the new construct of *perceived behavioral control* (Ajzen, 1991).

- Perceived behavioral control is defined as "the perceived ease or difficulty of performing the behavior" (Ajzen 1991, p. 188).

Ajzen (1991) states "attitudes toward the behavior, subjective norms with respect to the behavior and perceived control over the behavior are usually found to predict behavioral intentions with a high degree of accuracy".

The Theory of Planned Behavior (TPB) is similar to TRA in that TPB also assumes that individuals are rational decision makers. Individuals assess perceived behavior control using a method similar to the expectancy-value model. For each in a set of control beliefs, individuals multiply the belief's strength by the perceived power of the control factor.

TPB has also been widely applied to understand the individual acceptance and use of different technologies (Harrison et al., 1997; Mathieson 1991; Taylor and Todd 1995).

2.2.3 Technology acceptance model

Davis' (1989) Technology Acceptance Model (TAM) is designed to predict information technology acceptance. Davis (1989) tailored it to information systems context and is adapted from TRA and TPB. But unlike TRA, TAM excludes "attitude" in order to better explain intention.

The main goal of TAM is to predict and explain the determinants of computer acceptance, and to generate a model, which is capable of explaining user behavior when applied to different end-user information technologies and user populations (Davis, Bogozzi, and Warshaw, 1989).

TAM is one of the utilized models in predicting technology acceptance. In TAM, system usage is determined by perceived usefulness (PU) and perceived ease of use (PEU) relating to attitude toward use that relates to intention and finally to behavior.

Davis (1989) suggests that perceived usefulness and perceived ease of use are the two most important individual beliefs about using an information technology. These two are defined as:

- Perceived ease of use: is “the degree to which a person believes that using particular system would be free of effort” and,

- Perceived usefulness: is “the degree to which a person believes that using a particular system would enhance his or her job performance”.

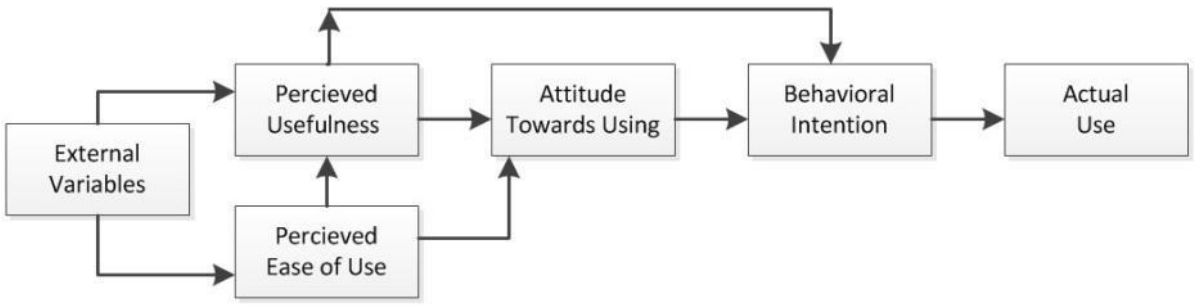

Figure 2.3 : Technology Acceptance Model by Davis (Davis, Bogozzi, and Warshaw, 1989)

According to TAM (Figure 2.3), perceived usefulness and perceived ease of use are the two determinants for an individual to accept or reject a new technology in organizations. But the studies showed that usefulness regarding perceived ease of use has a greater influence on system use. As a result; “… users are driven to adopt an application primarily because of the functions it performs for them, and secondarily for how easy or hard it is to get the system to perform these functions” (Davis, 1989). As it is in TRA, TAM also agrees that actual use is determined by behavioral intention (BI) while BI is jointly determined by attitude toward behavior and perceived usefulness. According to Davis (1989) “subjective norm” is the least understood scale in TRA, for this reason it is excluded from TAM.

One of the main criticisms of the TAM was that external factors such as the influence of individual user variables on technology acceptance were almost completely disregarded.

Another criticism of the TAM is the usage of the system to be tested should be voluntary (Adams et. al., 1992)

TAM has been used to explain technology acceptance for diverse set of technologies and users (Venkatesh & Davis, 1996) (Venkatesh & Davis, 2000) (Malhotra & Galletta, 1999) (Hiramatsu, Yamasaki and Nose, 2009).

2.2.4 Technology acceptance model 2

Technology Acceptance Model 2 (TAM2) is adapted from TAM and includes subjective norm, experience, voluntariness, image, job relevance, output quality, result demonstrability. The base model, TAM, aims to explain user acceptance of information systems within organizations. But TAM lacks of the factors important to understand the acceptance of internet applications.

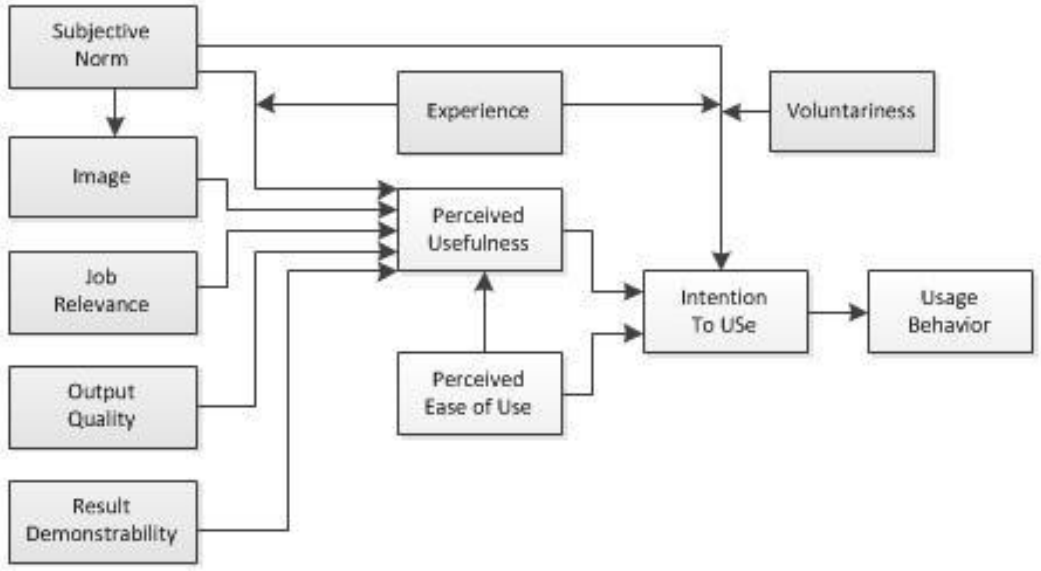

Figure 2.4 : TAM2 – Extension of TAM (Venkatesh and Davis, 2000)

In their model (Figure 2.4), Venkatesh & Davis (2000) offered that personal image and job relevance should affect usefulness.

According to TAM2 there are four determinants of perceived usefulness: job relevance, output quality, result demonstrability, and perceived ease of use. TAM2 retains perceived ease of use from TAM as a direct determinant of perceived usefulness.

Subjective norm component plays an important role in explaining the user acceptance. Accordingly, Venkatesh and Davis (2000) use the subjective norm to capture social influences. TAM2 suggests that in mandatory contexts, subjective norm has a direct effect on intention.

TAM2 posits that job relevance has a positive effect on perceived usefulness. Also, output quality is another determinant of perceived usefulness. Output quality refers to an individual's perception about how well the system performs the tasks (Long Li, 2008) and it has a positive effect on perceived usefulness. Result demonstrability is the third determinant of perceived usefulness. It is defined as the "tangibility of the results of using the innovation" (Moore and Benbasat, 1991). TAM2 posits that result demonstrability has also a positive effect on perceived usefulness.

2.2.5 Combined TAM and TPB

Taylor and Todd (1995) develop a new model by combining the predictors of TPB with the constructs of TAM which are perceived usefulness and ease of use. Figure 2.5 shows the model and its constructs:

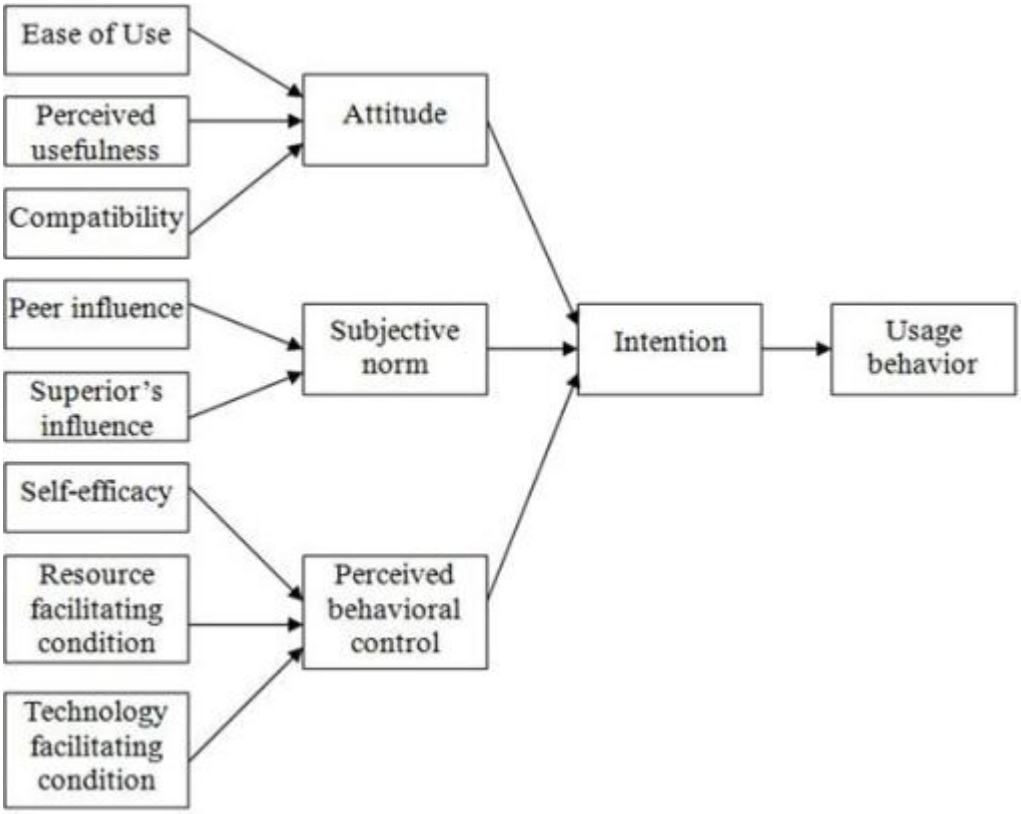

Figure 2.5 : Combined TAM and TPB (Taylor and Todd, 1995)

This model (Figure 2.5) is also called the Decomposed Theory of Planned behavior because the belief structure is decomposed in the model. In contrast to TPB but similar to TAM, DTPB "decomposes" attitude, subjective norm, and perceived behavioral control into it's the underlying belief structure within technology acceptance contexts.

In the model, the attitude is decomposed to include perceived usefulness, perceived ease of use and compatibility. The normative belief structure includes peer influence and superior influence. The control belief structure includes self-efficacy, resource facilitating conditions and technology facilitating conditions.

This model intended to test whether the variables that determine information technology usage are the same for experienced and inexperienced users. Perceived usefulness, attitude toward behavior and perceived behavioral control were more salient with increasing experience, on the other hand, subjective norm became less salient with increasing experience.

2.2.6 Motivational model

Several studies about pscyhology have supported motivation theory as an explanation for behavior. Vallerand (1997) designed theoratical base of Motivational Model (MM) which distinguishes two sorts of motivation, namely extrinsic and intrinsic motivation. The motivational model (Figure 2.6) posits that motivation must be considered from multidimensional perspectives. Vallerand proposes five main elements that are critical for hierarchical model:

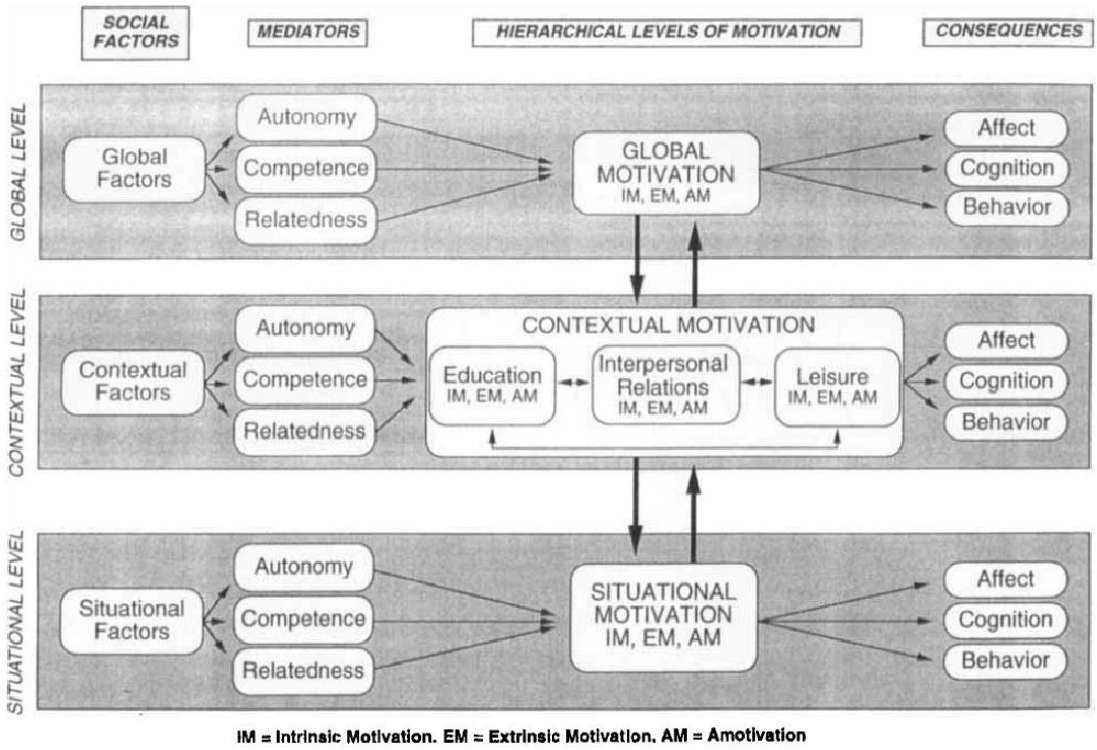

Figure 2.6 : The Hierarchical Model of Intrinsic (IM) and Extrinsic Motivation (EM), AM: Amotivation (From Vallerand 1995)

- First indicates that three motivations, namely intrinsic, extrinsic and amotivation, should be examined when evaluating motivation.

- The second states that these motivations (IM, EM and AM) exist in each individual at the global, contextual and situational levels.

- Third principle states that motivation at any level results from two sources: social factors and environmental conditions. And motivation transfers between levels.

- The fourth indicates that there is a recursive effect specifically from a lower level to above level.

- Final principle states that motivation leads to important behavioral, cognitive and affective consequences (Vallerand, 1997)

Davis et al. (1992) also studied about motivational model. Their study was about intrinsic and extrinsic motivation to use computers in the workplace. From this perspective:

- Extrinsic motivation: refers to the perception that an individual wants to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself such as improved job performance" (Davis et al., 1992). Perceived usefulness, perceived ease of use, and subjective norm are examples of extrinsic motivation.

- Intrinsic motivation: refers to the perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al., 1992) Computer playfulness and enjoyment are examples of intrinsic motivation (Davis et al., 1992).

According to their study, people's intention to use computers at the workplace is influenced mainly by their perception of how useful the computers are, and secondarily by the degree of enjoyment during the usage. Moreover, the study indicated that increasing the enjoyability of a system would encourage the acceptance of useful systems but have less of an effect on acceptance of useless systems (Davis et al., 1992)

2.2.7 Model of pc utilization

The Model of PC Utilization (MPCU) is an adaptation of Triandis' (as cited in Thomson et al., 1991) theory of attitudes and behavior. This model presents a competing perspective to that proposed by TRA and TPB and has been used to predict PC Utilization.

According to Thomson et al. (1991), Triandis' model implies that the utilization of a PC by a knowledge worker in an optional use environment would be influenced by the individual's feelings (affect) toward using PCs, social norms in the work place concerning PC use, habits associated with computer usage, the individual's expected consequences of using a PC, and facilitating conditions in the environment conducive to PC use.

Thomson et al. (1991) make a distinction between cognitive and affective components of attitudes. Beliefs belong to the cognitive component of attitudes. "Behavior is determined by what people would like to do (attitudes), what they think they should do (social norms), what they have usually done (habits), and by the expected consequences of their behavior" (Thompson et al., 1991, p.126).

Thompson et al. (1991) refine Triandis' model to predict PC utilization behavior (Figure 7). The major constructs in the model and their definitions include:

- Job-fit: "the extent to which an individual believes that using [a technology] can enhance the performance of his or her job" (p. 129). It is very similar to TAM's perceived usefulness construct and is widely accepted and researched determinant of technology acceptance.

- Complexity: "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 128).

- Long-term consequences: "Outcomes that have a pay-off in the future" (p. 129). Such outcomes could be, for example, better career mobility, better opportunity for more meaningful work or even a raise in one's salary. According to Thompson et al. (1991), "for some individuals, the motivation to adopt and use PCs may relate more to building or planning for the future than to addressing current needs".

- Affect Towards Use: "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (p. 127).

- Social Factors: “individual’s internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations” (p. 126). According to Venkatesh et al. (2003), social factors reflect what individuals think they are expected or even required to do. An individual may adopt a system if his or her co-workers have already adopted it, if manager or if the organisation has supported the acceptance of technology.

- Facilitating Conditions: “provision of support for users of PCs may be one type of facilitating condition that can influence system utilization” (p. 129). According to Thomson et al. (1991), facilitating conditions are objective institutional factors that make an act, such as technology acceptance, for the individuals easier to accomplish.

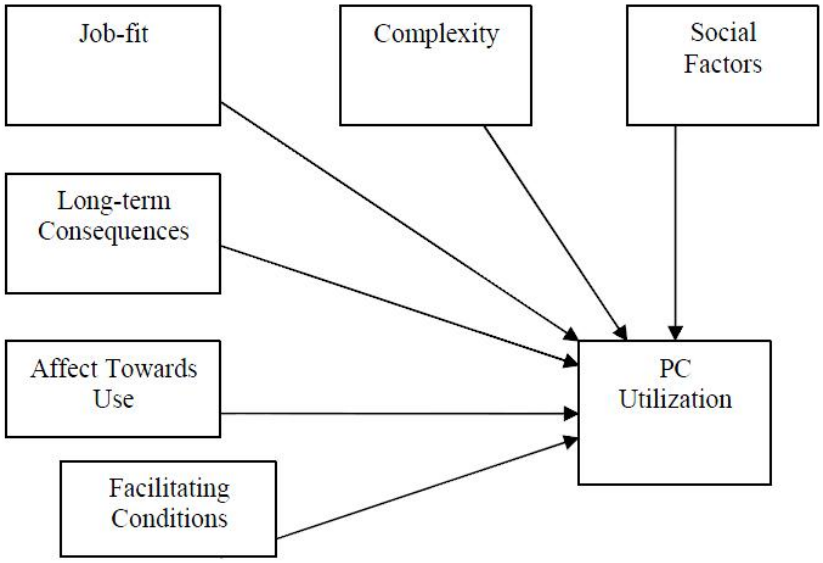

Figure 2.7 : The Model of PC Utilization (Thompson et al., 1991)

In their model (Figure 2.7), Thompson et al. (1991) states that utilization of PC would be influenced by individuals’ feelings toward using PCs, social factors, the expected consequences and the facilitating conditions. Besides, the dimensions of perceived consequences for utilizing personal computers at the work place included two short-term consequences (complexity and job-fit) and long-term consequences such as planning for the future.

MPCU is adapted and refined from Triandis’ model for IS contexts and used to predict PC utilization. For this reason, the nature of the model makes it particularly suited to predict individual acceptance.

2.2.8 Innovation diffusion theory

Rogers (1976) defines diffusion as “the process through which and innovation is communicated through certain channels over time among the members of a social system.” He proposes innovation, communication channels, time and the social system as the components of diffusion.

Innovation Diffusion Theory (IDT) is mainly based on the characteristics developed by Rogers (2002). Then five constructs from Rogers’ initial theory were first utilized and refined, and two additional constructs were then added based on research of other similar studies. IDT has been used to study a variety of innovations. Similar to previous models, IDT proposes that adopters’ behavior can be predicted based on how they perceive the primary attributes of the technologies (Hakkarainen, 2013).

Rogers identifies five attributes of an innovation that influence the adoption and acceptance behavior: relative advantage, complexity, compatibility, trialability, and observability. In the Information Systems field, Moore and Benbasat (1991) expand this attributes set to study information technology acceptance. The set includes:

- Relative Advantage: “the degree to which an innovation is perceived as being better than its precursor” (p. 195).

- Ease of use: “the degree to which an innovation is perceived as being difficult to use” (p. 195).

- Image: “The degree to which use of an innovation is perceived to enhance one's image or status in one's social system” (p. 195).
- Visibility: The degree to which one can see others using the system in the organization.
- Compatibility: “the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters” (p.195).
- Results Demonstrability: “the tangibility of the results of using the innovation, including their observability and communicability” (p. 203).

- Voluntariness of Use: “the degree to which use of the innovation is perceived as being voluntary or of free will” (p. 195).

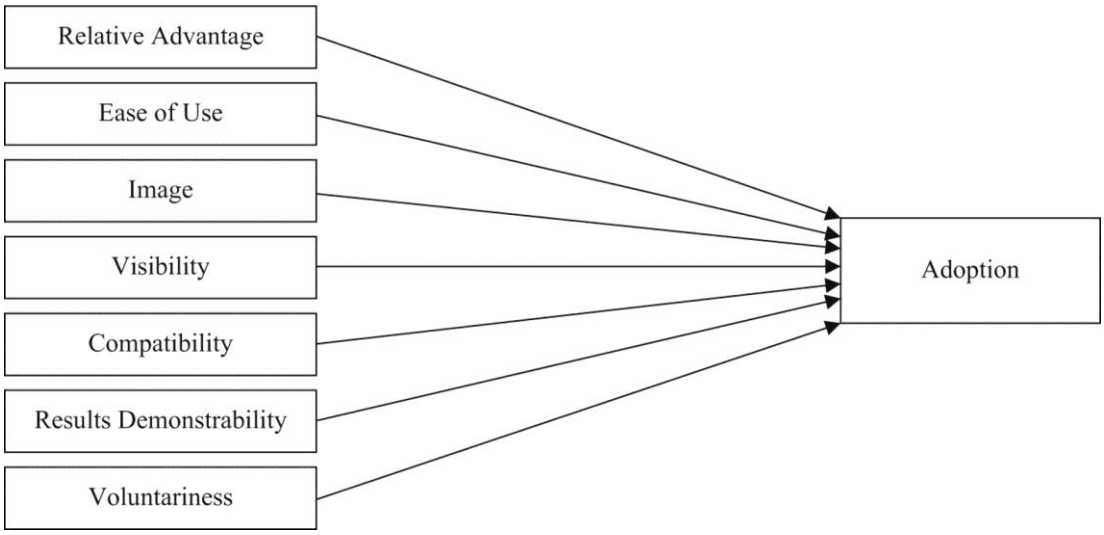

Figure 2.8 : Adoption Theory by Moore and Benbasat (1991)

As shown in the Figure 2.8, Moore and Benbasat (1991) offer seven scales in their study. They recommend using this model to investigate how perceptions affect individuals' actual use of IT as well as other innovations.

2.2.9 Social cognitive theory

Bandura's Social Cognitive Theory (SCT) (1986, in Bandura and Wood, 1989) explains human behaviour and it is extended by Compeau and Higgins (1995). Social Cognitive Theory suggests that environmental factors, personal factors (in the form of cognitive factors, affective factors etc.), and behaviors are determined reciprocally (Figure 2.9).

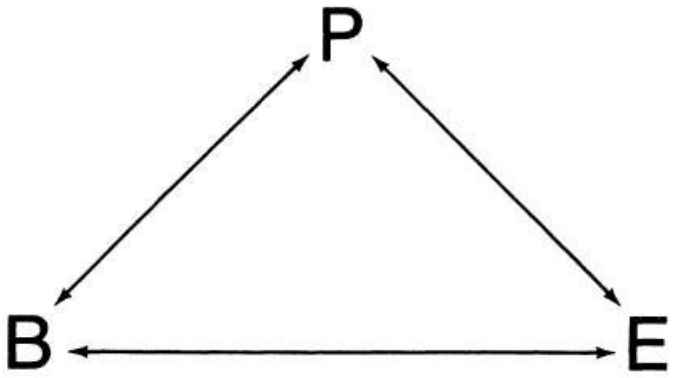

Figure 2.9 : Shematization of the relations among behavior (B), cognitive and other personal factors (P), and the external environment (E), in Bandura and Wood (1989)

For the P-B relation in the model; expectations, beliefs, self- perceptions, goals and intentions shapes and direct behavior. For the relationship between E and P,social cognitive theory states that social influences enhance one's expectations, beliefs, emotional bents and cognitive competencies. Besides, people can affect their social environment by their social status and characteristics. On the other hand, B-E refers that, behavior and environmet affect each other (Bandura, 1989).

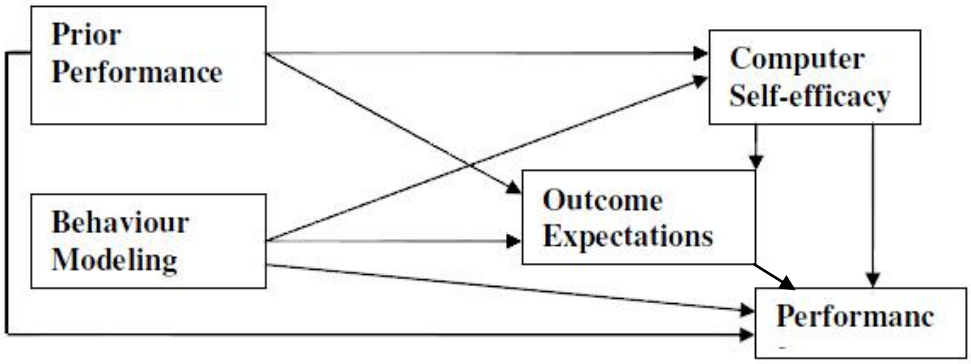

Figure 2.10 : Social Cognitive Theory (Compeau and Higgins, 1995)

The Social Cognitive Theory gives importance to the concept of self-efficacy (Compeau et al., 1999). Self-efficacy is defined as the judgment of one's ability to use a technology to accomplish a particular job or task (Compeau and Higgins, 1995).

Compeau and Higgins (1995) formulated a research model that based on Social Cognitive Theory. The proposed model (Figure 2.10) theorizes that prior performance and behaviour modeling directly impacting self efficacy, outcome expectations and performance. While self efficacy was posited to influence outcome expectations and performance, outcome expectations was also posited to influence performance. As in the other models, performance construct states that an individual is more likely to take an action if he or she believes it will result in desired outcome, such as better performance in work-related tasks. Performance-related outcome expectations are interested in job-related outcomes. Personal-related outcome expectations are interested in individuals' esteem and sense of accomplishment (Compeau and Higgins, 1995).

2.2.10 Unified theory of acceptance and use of technology

Based on the most significant constructs from the above eight theories and models, Venkatesh et al. (2003) formulate a new model called the Unified Theory of Acceptance and Use of Technology (UTAUT). UTAUT suggests that four constructs play an important role as direct determinants of intention to use an information technology. These four constructs are performance expectancy, effort expectancy, social influence and facilitating conditions (Venkatesh et al., 2003). Besides, attitude toward using technology, self-efficacy and anxiety are theorized not to be direct determinants of intention to usage.

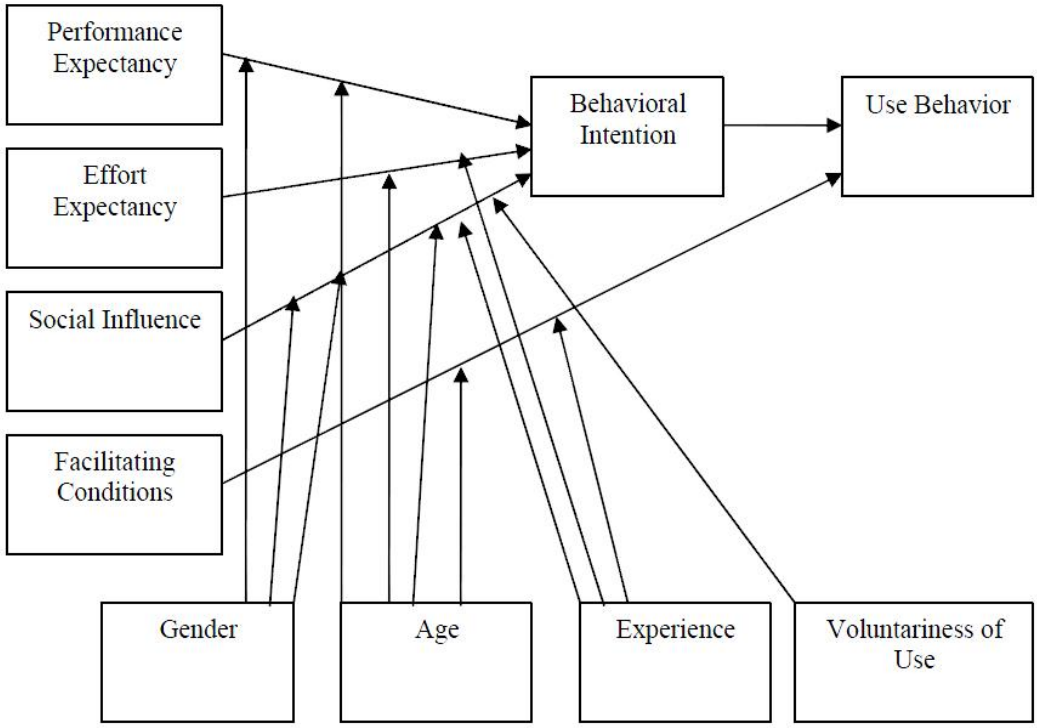

Figure 2.11 : The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

Performance Expectancy

Performance expectancy is defined as "the degree to which the user expects that using the system will help him or her attain gains in job performance". It corresponds with perceived usefulness of TAM/TAM2/C-TAM-TPB, extrinsic motivation of MM, job-fit of MPCU, relative advantage of IDT and outcome expectations of SCT. Performance expectancy and intention proposed to be moderated by gender and age.

Effort Expectancy

Effort expectancy is defined as "the degree of ease associated with the use of the system". It corresponds with perceived ease of use of TAM/TAM2, complexity of MPCU and ease of use of IDT. Effort expectancy construct is significant in both voluntary and mandatory usage. It is proposed to be effective for women, particularly those who are older and with relatively little experience with the system.

Social Influence

Social influence is defined as "the degree to which an individual perceives that important others believe that he or she should use the new system". It is similar to subjective norm in TRA/TAM2/TPB/C-TAM-TPB, social factors of MPCU and image of IDT. Social influence is taken into consideration in UTAUT, and it is suggested to be moderated by gender, age, experience and voluntariness of use so that the effect is theorised to be more effective for women and older workers, under conditions of mandatory use and with limited experience.

Facilitating Conditions

Facilitating conditions are defined in UTAUT as "the degree to which an individual believes that an organizational and technical infrastructure exist to support use of the system". It corresponds with the perceived behavioral control of TPB/DTPB/C-TAM-TPC, facilitating conditions of MPCU and compatibility of IDT. UTAUT theorise that facilitating conditions do not have significant influence on behavioural intention due to the fact that this effect has been theorised to be captured by effort expectancy. Therefore, UTAUT model suggests that facilitating conditions influence usage behaviour directly without it being mediated by usage intention so that the effect is moderated by age and experience in such a way that the impact is stronger for older workers with increasing experience. (Venkatesh et al., 2003)

UTAUT model attempts to explain how individual differences influence technology use. More specifically, gender, age, experience and voluntariness of use are the moderators of the model. These moderators have contribution to a better understanding of the complexity of technology acceptance by individuals.

Attitude, Anxiety, and Self-Efficacy as Moderators

UTAUT does not include attitude, anxiety, and self-efficacy as direct determinants. Attitude, anxiety, and self-efficacy are conceptually and empirically distinct from effort expectancy. They have been modelled as indirect determinants of intention (Venkatesh, 1999).

UTAUT defines attitude toward using technology as "an individual's overall affective reaction to using a system" (Venkatesh et al., 2003). According to Venkatesh et al. (2003) effect of attitude is captured when performance expectancy and effort expectancy are removed from the model. For this reason they excluded attitude from the model. Contrary to Venkatesh et al. (2003), Davis et al. (1989) states that attitude has shown to be a strong predictor of behavioural intention.

Anxiety refers to the participant's self-reported hesitation when using the system. When a user has a negative attitude towards the technology they are encouraged or required to use, it is likely that they view the technology as a source of anxiety. Thus, they will have low intention to use the technology. UTAUT excludes anxiety from the model, because anxiety was found to be mediated by effort expectancy (Venkatesh et al., 2003).

Self-efficacy refers to the participant's judgment of their ability to perform a behaviour that exercises influence over events (Bandura, 1994). Self-efficacy beliefs determine how people think, feel, become motivated, and behave, and it is likely to have an important influence on the intention to use information technology and actual use behavior. But like anxiety, UTAUT also excludes self-efficacy from the model. Venkatesh et al. (2003) could not find a significant effect of self-efficacy on system use.

It should be pointed out that UTAUT describe and explain the organizational acceptance of a technology. The model accounted for 70 percent of the variance in usage intention.

2.2.11 Unified theory of acceptance and use of technology 2

Understanding individual acceptance and use of technology is one of the most research areas of the researchers. Unified theory of acceptance and use of technology has emerged as a review and synthesis of eight theories of technology use (Venkatesh et al., 2003). UTAUT has tried to clarify critical factors and contingencies related to the prediction of behavioral intention to use a technology and technology use primarily in organizational context.

UTAUT has served a baseline model and has been applied to many studies about different technologies both organizational and non-organizational settings. But still there is a need for a systematic investigation and theorizing of the related factors that would apply to a consumer technology use context (Venkatesh et al., 2012). UTAUT2 is designed for paying attention to consumer use context.

UTAUT2 has kept general outlines of the UTAUT which is tailored to consumer use context as shown Figure 2.12. According to UTAUT, performance expectancy, effort expectancy, and social influence are theorized to influence behavioral intention to use a technology, while behavioral intention and facilitating conditions determine technology use (Venkatesh et al., 2012). In UTAUT2 moderators are age, gender, and experience. Different from original UTAUT, voluntariness has been dropped as a moderating variable, because of making UTAUT applicable in the context of voluntary behavior. Hedonic motivation, price value and habit constructs have been added to UTAUT2.

Hedonic motivation is defined as **"**the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use" (Brown and Venkatesh, 2005). Brown and Venkatesh (2005) have thougt that in consumer context, hedonic motivation has also been an important determinant of technology acceptance and use. For this reason it has been added to model as a predictor of behavioral intention to use a technology.

Price Value is defined as "consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them" (Dodds et al., 1991). The price value is positive when the benefits of using a technology are perceived to be greater than the monetary cost and such price value has a positive

impact on intention (Venkatesh et al., 2012). Thus, price value has been added as a predictor of behavioral intention to use a technology.

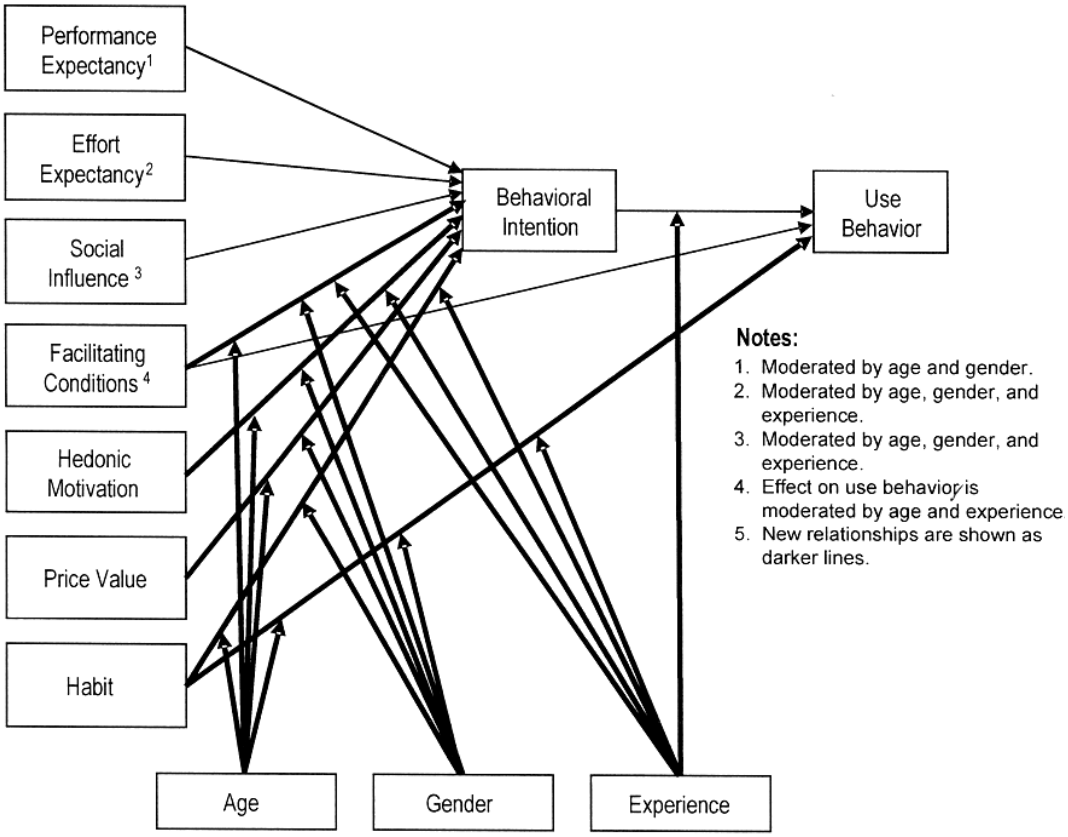

Figure 2.12 : Unified Theory of Acceptance and Use of Technology 2 (Venkatesh et al., 2012)

Habit has been defined as "the extend to which people tend to perform behaviors automatically because of learning (Limayem et al., 2007). Venkatesh et al. (2012) added habit as a perceptual construct that reflects the result of prior experiences.

2.3 Studies with UTAUT as a Research Model

Information Technology (IT) acceptance is very crucial for both individual and organizational context. For this reason especially organizations want to know if their new technology/product will be used or not. Through the development of technology acceptance literature, researchers have tried to understand technology acceptance models and they have tested them with their software/products/technologies. Examples of different acceptance studies listed below:

- **3G communication**

Wu et al. (2007) used UTAUT to explore the acceptance of 3G mobile communication among users. They have tried to analyze Taiwan's mobile telecommunication companies which design strategies and tactics for providing customer-oriented 3G services to both existing and potential customers. They found that among the four determining factors that influence the acceptance of 3G hand phones, only Effort Expectancy has no influence on the users' Behavioural Intention.

- **Banking**

Wang and Yang (2005) analyzed technology acceptance of online stock exchange using UTAUT model. In this research, Wang and Yang (2005) tried to combine the theory of personality traits with UTAUT model in two ways. The personal traits studied were the big five factors (or FFM) categorizing personality traits into: extraversion, conscientiousness, agreeableness, neuroticism, and openness. In their research design, the personality traits were hypothesized to affect intention to adopt online stock exchange indirectly through UTAUT constructs in the first design model and in the second model to moderate the effect of UTAUT constructs on intention to adopt online stocking. Main result of the study was that personality traits (Extraversion, Conscientiousness, Agreeableness, Neuroticism and Openness) play more important roles as moderators than as variables.

AbuShanab and Pearson (2007) tried to investigate the key determinants of acceptance of internet banking in Jordan and also validate the appropriateness of the UTAUT within the context of internet banking. According to the study, Performance Expectancy, Effort Expectancy and Social Influence were significant and explained a significant amount of the variance in predicting a customers' intention to adopt banking.

Martins et al. (2014) combined unified theory of acceptance and use of technology (UTAUT) with perceived risk to explain behaviour intention and usage behaviour of Internet banking. The study found that Performance Expectancy, Effort Expectancy, Social Influence and Risk predict Behavioral Intention. Besides, BI predicts usage behaviour of internet banking.

- **Education**

Rahman et al. (2011) investigated the factors that are expected to influence the intention of postgraduate students to use digital library based on modified UTAUT model.

Chang (2013) integrate the unified theory of acceptance and usage of technology (UTAUT) with task technology fit to explain users' behavioral intention of using library mobile applications in university libraries. According to the study, PE, EE, SI, and FC determine users' BI of using library mobile applications. Moderating effect of Task Technology Fit is also significant.

- **Health**

Kijsanayotin et al. (2009) employ a modified UTAUT structural model, to understand factors that influence CHC health IT acceptance in Thailand and to validate this extant IT acceptance model. IT acceptance is influenced by PE, EE, SI and voluntariness. Health IT use is predicted by previous IT, BI to use the system, and FC.

Kohnke et al. (2014) studies on acceptance of healthcare telemedicine equipments. Drawing from the UTAUT, this study investigated the predictors of behavioral intention to use Telehealth equipment by patients, clinicians, and agency personnel. Kohnke et al. (2014) substantiated that PE, EE and SE influence BI. On the other hand, anxiety had minimal moderation on BI.

All these studies show that UTAUT is being used by wide variety of contexts. 3G communication, banking, education and health are examplified above.

2.4 Studies with UTAUT as a Research Model on a Product

Technology acceptance is a term which is evolved for information systems. But in time, acceptance of every new "product" has been researched and "acceptance" by users has been tried to understand. Below there are examples of studies which use UTAUT as a research model and focus on acceptance of products.

Carlsson et al. (2006) searched the answers to the acceptance rates by testing the applicability of the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain the acceptance of mobile devices/services. The effect of attitude toward

using mobile device/ services and mobile device/services anxiety on behavioural intention and the use of mobile services were examined in addition to the original paths in the model. They have found that performance expectancy, effort expectancy and attitude towards mobile devices/services could be found as explanations for behavioral intention, but that social influence and anxiety could not be used as for explanations. They also substantiated that behavioral intention would have a positive influence on usage. On the other hand, facilitating conditions did not have link to the use of mobile services.

Wong et al. (2013) tried to understand early childhood student teachers' self-reported acceptance and use of interactive whiteboard (IWB), by employing the Unified Theory of Acceptance and Use of Technology (UTAUT) as the research framework. It is found that teachers will only involve themselves with the new Smart Board technology when they can see the benefits and value of using it. It clearly shows that policy makers and curriculum designers should consider promoting the advantages of using this technology and organize training sessions of its usage. A higher effort expectancy level of the Smart Board will increase the level of behavioral intention of the teachers in using the smart board.

Simsek (2008) has studied product acceptance in military context. Newly designed military products (Figure 2.13) have been tried to be tested by UTAUT. Simsek (2008) aimed to analyze factors that affect user behavior and their significance in military context.

Figure 2.13 : Military products that are tested with UTAUT (Simsek, 2008)

According to the findings of the study, many measures in literature seem to be secondary measures when evaluating a new military product. Namely, social

influences, reliability, facilitating conditions, complexity, anxiety, physical characteristics of the product and self-efficacy have no direct effect on user attitude. But performance expectancy and effort expectancy have meaningful effect on military product acceptance. These measures influence users' perception of the utility out of the usage of the product and result in positive attitudes (Simsek, 2008).

Different from other UTAUT studies, Simsek (2008) tried to understand the effect of physical characteristics of product on acceptance. Physical characteristics of military products were proposed to be effective on users' performance expectancy, effort expectancy, self-efficacy and anxiety. Correspondingly, the research proved that the PCoP is effective on users' performance and effort expectancy, whereas it is not effective on self-efficacy and anxiety.

3. USABILITY AS A DIMENSION OF ACCEPTANCE

According to Dillon and Morris (1996) the more usable a technology is, the more it is accepted. From that point of view, usability is one of the most important dimensions of product acceptance. This chapter will start with definition of usability and then try to detail different approaches about usability from the acceptance perspective.

3.1 Definition of Usability

Designers in different fields, e.g. consumer products and interface design, are aware that their products need to be designed so that users can use them to a satisfying level. The designers aim for products with high usability.

Although usability has widespread recognition, there is still confusion over the meaning of the term. (Bevan et al. (1991) categorize the usability definitions according to the views of how usability should be measured:

- the product-oriented view that usability can be measured in terms of ergonomic attributes of the product;
- the user-oriented view, that usability can be measured in terms of mental effort and attitude of the user;
- the user-performance view that usability can be measured by examining how the user interacts with the product, with particular emphasis on either
- ease-of-use: How easy the product is to use, or
- acceptability: Whether the product will be used in the real world (Bevan et. al,1991).

Usability is a combination of many different properties and attributes. International Organization for Standardization (ISO 9241-11, 1998) 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."

According to ISO 9241-11 (1998) usability is an important consideration in the design of products because it is concerned with the extent to which the users of products are able to work effectively, efficiently and with satisfaction. Effectiveness is the accuracy and completeness with which users achieve specified goals. Efficiency is the resources expended in relation to the accuracy and completeness of goals achieved. Satisfaction is the comfort and acceptability of the work system to its users and other people affected by its use (ISO 9241-11, 1998).

3.2 Usability as a Dimension of Acceptability

Dillon and Morris (1996) state that the more usable a technology is, the more it is accepted. From that point of view, importance of usability in terms of product acceptance is critical. Brian Shackel (1991), Jacob Nielsen (1993), Dillon and Morris (1998) and ISO 9241 DIS part 11 (1998) raise questions about usability measurements at an operational level, about usability objectives and about the relationship between usability, utility, product acceptance and affect in relation to the interaction.

3.2.1 Shackel's approach

Shackel (1991) located usability in the context of acceptance. "Usability of a system or equipment is the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios," or in short "the capability to be used by humans easily and effectively" (Shackel 1991, p. 24)

According to Shackel (1991), usability is a property of a system or a piece of equipment. Shackel (as cited in Keinonen, 1998) states that usability works together with utility, likeability, and costs to form product acceptance. He defines these elements; utility as "the match between user needs and product functionality"; usability as "user's ability to utilize the functionality in practice"; likeability as "effective evaluations"; costs as financial and social expenses. Shackel suggests

effectiveness, learnability, flexibility, and attitude as four dimensions of usability (as cited in Keinonen, 1998).

For a system to be usable it has to achieve defined levels on the following scales:

- effectiveness, meaning the results of interaction in terms of speed and errors;
- learnability, meaning the relation of performance to training and frequency of use, i.e. the novice user's learning time with specified training and retention on the part of casual users;
- flexibility, allowing adaptation to tasks and environments beyond those first specified;
- attitude, meaning "acceptable levels of human costs in terms of tiredness, discomfort, frustration and personal effort". (Shackel, 1991)

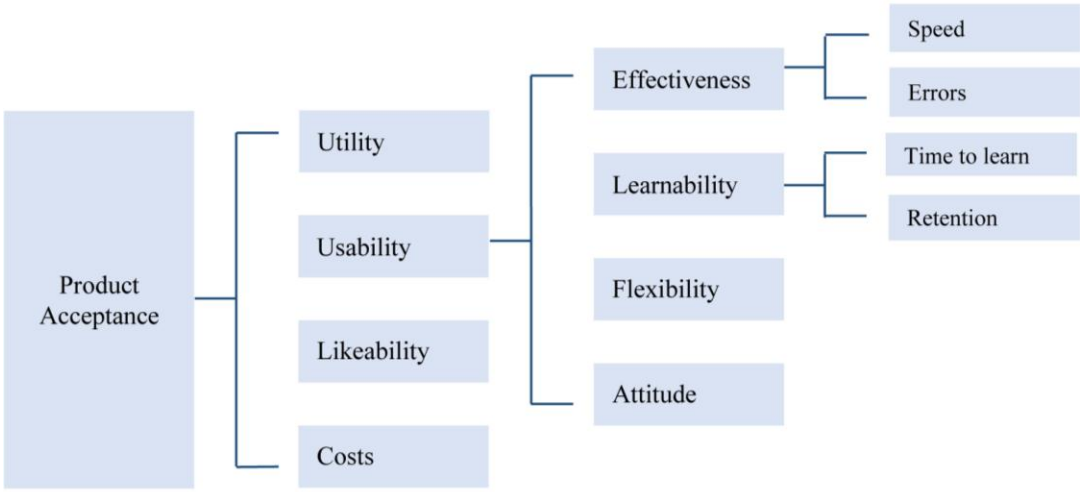

Figure 3.1 : Shackel's model of product acceptance model; in Keinonen (1998)

Figure 3.1 summarises Shackel's suggestions about usability and related concepts. His usability definition draws a framework of evaluation and finally suggests concrete measurable usability criteria.

3.2.2 Nielsen's approach

Nielsen (as cited in Keinonen, 1998) considers usability as "an aspect among others influencing product acceptance". Besides, Nielsen (1993) thinks that a useful system can be formed by usability and utility together. He describes utility as the question of "whether the functionality of the system in principle can do what is needed?", and usability as the question of "how well users can use that functionality?". Nielsen

(1993) divides product acceptance as social and practical acceptance and regards usefulness together with other perceived product attributes like cost, reliability, and compatibility as a factor of practical acceptability (Keinonen, 1998) (Figure 3.2).

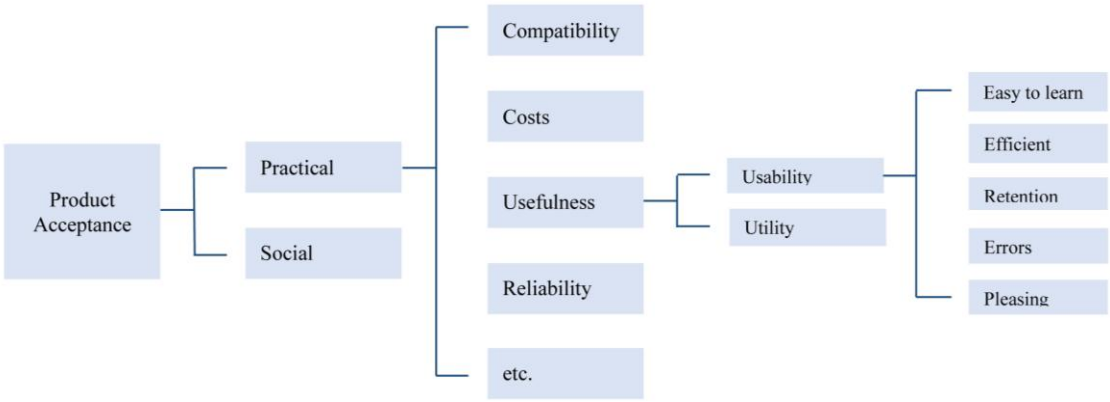

Figure 3.2 : Nielsen's model of product acceptance; in Keinonen (1998)

Nielsen (1993) does not define usability itself but defines usability criterias. These criterias are:

- Learnability refers to the novices' ability to reach a reasonable level of performance rapidly. Nielsen considers learnability a fundamental criterion, because all systems with few exceptions have to be learned for efficient use.
- Efficiency refers to the expert user's level of performance, which is typically measured by the speed of performance.
- Memorability refers to the casual user's ability to remember how to use a system after a period of time.
- Errors refer to the number of errors users make, to their ability to recover from errors, and to the existence of catastrophic errors, which destroy the user's work.
- Satisfaction refers to users' subjective assessment of the system concerning how pleasant it is to use. As a sub dimension of satisfaction Nielsen mentions approachability, which measures how usable subjects consider a system to be prior to actual use. Nielsen does not expect high correlation between approachability and usability. Questionnaires are introduced as the most obvious way to measure satisfaction. However, the amount of voluntary use is suggested as *"the ultimate subjective satisfaction rating."* (Nielsen, 1993).

3.2.3 ISO 9241 part 11 DIS

ISO 9241 DIS is a draft international standard for the ergonomic requirements for office works with visual display terminals (ISO 1994). Part 11 discusses usability for the purposes of product requirement specifications and product evaluation.

ISO 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” (ISO 9241-11 Guidance on usability, 1998). (Figure 3.3)

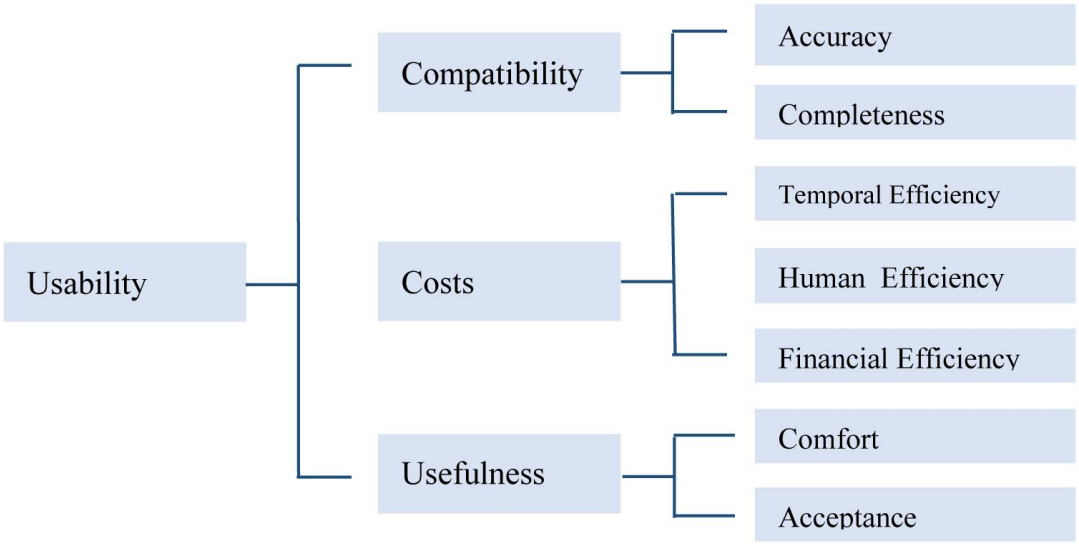

Figure 3.3 : Dimensions of usability according to ISO 9241-11 (Keinonen, 1998)

- Effectiveness refers to the accuracy and completeness with which users achieve specified goals.
- Efficiency refers to the resources expended in relation to the accuracy and completeness with which users achieve goals.
- Satisfaction refers to the comfort and acceptability of use (Keinonen, 1998)

On the other hand, ISO 9241-11 was originally influenced by the European ESPRIT project MUSiC (Metrics for Usability Standards in Computing). The MUSIC defines usability as “the ease of use and acceptability of a system or product for a particular class of users carrying out specific tasks in a specific environment; where ‘ease of use’ affects user performance and satisfaction, and ‘acceptability’ affects whether or not the product is used.” (Bevan et al., 1991)

The usability of a product is always studied in relation to users, goals and context. ISO 9241 separates usability from quality of work by selecting a specific point of view. Usability studies the quality of work by focusing on the product. While Shackel and Nielsen regard usability as an aspect of consumer product acceptance, ISO 9241 regards it as a special focus on the evaluation of the quality of work (Keinonen, 1998).

3.2.4 Dillon and Morris' p3 model

Dillon and Morris's (1998) P3 Model is the other acceptance model that uses usability as an acceptance determinant. Dillon and Morris' (1998) state that use of information technology is driven by utility; "technical capability of the tool", usability; "the extent to which users can exploit the utility of the system" and user attitude: users' preference between equivalent alternatives regarding their past experiences. These three factors are conceptualized through three Ps: Power, Perception and Performance.

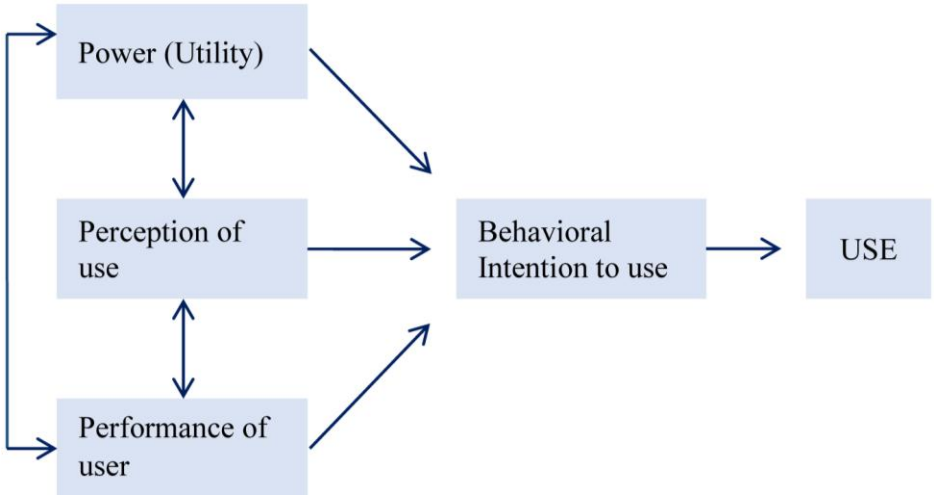

Figure 3.4 : Dillon and Morris' P3 Model of Use (1998).

In their model (Figure 3.4); three constructs determine the users' intention towards the use of application. These are;

- Power is defined as "an objective measure of the applications capability/functionality"
- Performance of user refers to "behavioral measures of usability"

- Perception of use is “perceptual measures of users like utility, usability etc.” (Dillon and Morris, 1998; p.5)

Usability and its extensions such as learnability and effectiveness together with utility and costs are important factors that users evaluate when they first encounter with a new product. Thus, taking in consideration of usability and its extensions increase probability of new product acceptance since it corresponds with users’ expectations.

4. MEDICAL CONTEXT AND PRODUCT ACCEPTANCE

Health care have close relationship with new technologies and new products. These new technologies try to reduce errors, increase safety and quality. For this reason, it is critical to understand the factors that influence new product acceptance in health context. In this chapter, definitions of medical devices and pediatric medical devices will be given. Then health technologies in bilirubin assessment will be introduced. Finally acceptance phenomenon in the context of health care will be explained.

4.1 Medical Device

According to the European Medical Device Directive (93/42/EEC, 1993), a medical device is; ...any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of;

- Diagnosis, prevention, monitoring, treatment or alleviation of disease,
- Diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,
- Investigation, replacement or modification of the anatomy or of a physiological process,
- Control of conception,

and which does not achieve its principle intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means.

Since a medical device has direct impacts on the health of patients in varying levels, the regulation of these devices become important. They have to be regulated, checked, tested and analyzed before they are allowed to use. The classification of medical devices in the European Unions is outlined in Annex IX of the Council

Directive 93/42/EEC. This classification depends on the device's potential to cause harm to the patient, user or other people. Levels of regulations increase from Class I devices to Class IIa-IIb devices and Class III devices need extensive testing. The lowest risk devices fall into Class I (Gelijns, 1989, p.28)

> Approximately 30% of all types of medical devices are in Class I. Furthermore, class I devices include such instruments as tongue depressors, which do not support or sustain human life and do not present a potentially unreasonable risk of illness or injury. About 60% of devices are in Class II. They may involve some degree of risk and are subject to federally defined performance standards (such as X-Ray devices) Finally, all devices that are life supporting or sustaining, that are of substantial importance in preventing impairment of health, or that have a potential for causing risk of injury or illness are in Class III. Approximately 10% of medical devices are in Class III, such as the artificial hearth, DNA probes or laser angioplasty devices (Gelijns, 1989, p. 27).

This classification is also very important in the strategic planning of the design process. Because the regulations changes according to medical device classes, during design phase classification of the developing product should be taken into consideration. Moreover, design, material selection, production, packaging would be in accordance with the class of medical device.

4.2 Pediatric Medical Devices

The International Conference on Harmonisation (ICH) gives age classification of pediatric patients in European Union. According to ICH (2000), a classification such as one below provides a basis for thinking about study design in pediatric patients.

The following Table 4.1 shows the age categorization. There are overlaps in developmental (e.g. physical, cognitive, and psychosocial) issues across the age categories. Ages are defined in completed days, months, or years (ICH, 2000).

Pediatric Subgroup	Aproximate Age Range
Preterm Newborn Infants	
Term Newborn Infants	0 to 27 days
Infants and Toddlers	28 days to 23 months
Children	2 to 11 years
Adolescents	12 to 18 years

Table 4.1 : Age range of Pediatric Subgroups (ICH)

Some products are designed specifically for children, while others are borrowed from adult applications or produced for more general use. Designing pediatric medical devices is crucial but it can be challenging because children often smaller and more active than adults, body structures and functions change throughout childhood, and children may be long term device users.

4.3 Medical Technologies

Technological change is generally held to be the primary driving force behind improved productivity and economic growth. And, technology can be so much more than a physical tool or product. It can be the knowledge and skills needed to operate a tool, it can be the knowledge used to solve problems or the pedagogical tools to extend the knowledge of others (as cited in Cetin, 2004).

Medical technology can, therefore, have a correspondingly broad definition, like the one proposed by The Office of Technology Assessment (OTA).

> "Technology is defined as "science or knowledge applied to a definite purpose". Thus, medical technology includes all elements of medical practice that are knowledge-based, including hardware (e.g., equipment and facilities) and software (e.g., knowledge and skills). Medical technology is defined as the set of techniques, drugs, equipment, and procedures used by health-care professionals in delivering medical care to individuals and the systems within which such care is delivered" (as cited in Cetin, 2004).

As the demands of the users of the medical devices became more and more clear, medical device companies tended to find new opportunities such as developing new technologies and new products. This was essential for them, where, rapidly changing market gave chance only to manufacturers and companies, which differ from the others in a radical way. Furthermore, applying new technologies to products, companies go one step further from others.

4.3.1 Medical technologies in bilirubin assessment tools for newborns

Definition of non-invasive is "done without cutting the body or putting something into the body" (Url-4, 2014). And, non-invasive hand-held bilirubin assessment tool is one of the pediatric devices which is used for measuring newborns' bilirubin level.

For newborns, bilirubin level is an important data for doctors because hyperbilirubineamia can occur at the very first hours after the birth. --Clinical evaluation of hyperbilirubineamia involves visual assessment of the yellowness of skin, known as jaundice. Visual estimation on the depth of jaundice is subjective and inaccurate which can be confounded by skin colour and haemoglobin (Krishnasamy, 2009).

Various methods have been developed to aid non- invasive diagnosis of hyperbiliruneamia and total serum bilirubin. Transcutaneous bilirubinometer is hand held and non- invasive method of measuring bilirubin level.

Since 2004, the American Academy of Pediatrics (AAP) has recommended that every newborn be examined for hyperbilirubinemia risk by either direct bilirubin measurement or a clinician's assessment. After birth, bilirubin levels rise in all newborns due to accelerated red blood cell breakdown. Normally newborns' bilirubin peaks within a week at a harmless level and then drops. But in some cases, hyperbilirubinemia is encountered in the newborn babies. It commonly occurs in approximately 65% of all full term babies with the peak bilirubin levels occurring on day 5 of life (Kolman et. al., 2007). A total serum bilirubin levels above a define threshold warrants treatment to prevent the development of kernicterus. Usually, the clinical evaluation of hyperbilirubineamia involves visual estimation of the yellowness of skin, known as jaundice.

Transcutaneous Bilirubinometry works by directing light into the skin of neonate and measures the intensity of specific wavelength that is returned. The number of wavelengths, used is variable in different transcutaneous bilirubinometers. The meter analyzes the spectrum of optical signal reflected from the neonate's subcutaneous tissues. These optical signals are converted to electrical signal by a photocell. These are analyzed by a microprocessor to generate a serum bilirubin value. The major skin components, which impart the spectral reflectance in neonate, are melanin, dermal maturity, hemoglobin and bilirubin.

Transcutaneous bilirubinometer available in the market are Philips Bilichek, Draeger Jaundice Meter and Med&Led Bilimed.

4.3.1.1 Philips bilichek

Bilichek (BC) (Url-3, 2014) is a device that analyses the light reflected from the newborn's skin with a multiwavelength spectral reflectance technique which determines optical densities respectively attributed to bilirubin and other skin pigments. BC provides a rapid and accurate measure of TSB. BC needs a disposable clean tip (called BiliCal®) for every measurement and calibration. In a recent review the American Academy of Pediatrics (AAP) recognised it as a significant improvement over the older devices (Ip et. al., 2004).

Figure 4.1 : Philips Bilichek

Bilichek (Figure 4.1) is one of the most common hand-held that is used for monitoring bilirubin level of newborns.

4.3.1.2 Draeger JM-103

JM-103 determines the yellowness of the subcutaneous tissue of a newborn infant by measuring the difference in optical densities for light in blue and green wavelength regions. The measuring probe has two optical paths. The differences between the optical densities are detected by blue and green photocells. By calculating the difference in optical densities, the parts that are common to the epidermis and dermis

will be reduced, and as a result the difference in optical densities between the two wavelength regions can be obtained for the subcutaneous tissue only (Romagnoli et. al., 2012).

Figure 4.2 : Draeger JM-103

Draeger JM-103 (Figure 4.2) (Url-2, 2014) has also common usage as Philips Bilichek. Some hospitals in Turkey have both of these hand-held bilirubinometers.

4.3.1.3 Med&Led bilimed

Bilimed is one another transcutaneous bilirubinometer which has been developed by MED&LED. This hand-held device is based on a new technology using a five-wavelength analysis; a higher measurement accuracy has been suggested, independently of gestational age and skin colour (Karen et. al., 2009).

Philips Bilichek, Draeger JM-103 and Med&Led Bilimed (Figure 4.3) (Url-1) are three examples of new health technologies that are developed for measuring bilirubin level without any invasive things to the newborns.

Figure 4.3 : MED&LED Bilimed

4.4 Medical Technologies and Design

Cetin (2004) states that medical device design is one of the most important and most promising field of industrial design. Medical devices were once designed by doctors, technicians and other people, who usually use such devices. But today medical product design has to be carefully undertaken by designers because of the importance of health.

Demands of the users from new medical devices have increasing steadily. Thus, medical device companies tend to give more importance to the design of their products. This is essential for them, because they have to differ from the others with new technologies and new products. Medical device design has come, therefore, at the corner of changing management strategies and the design intelligence.

Allen (2001) states that, design is no longer considered as a styling option for medical products. It is understood to be an authentic expression of the technology and use of most medical instrumentation. The advantages for medical device manufacturers in creating an early design vision include quicker development time, better manufacturability, holistically designed products that meet a full range of needs, and products that are better coordinated with the company's brand message.

Medical device design has an interdisciplinary structure among biomedicine, engineering and product design, where the aim is to find the best technical solutions and design alternatives for safety and better medical devices. It has a very important and critical mission, as the object is human life. The main purpose of medical device

design activity is to make a device usable by a person with health problems or by a person who is responsible for caring health problems.

4.5 Medical Device Acceptance

The user acceptance defines whether the product will be used in the real world (Bevan et al., 1991) whereas; the contrary situation is the rejection of the product or the user resistance (Jiang et al., 2000) which can be observed as non-purchase or non-use. These consequences are unbearable for producers and users because in both situations, the money invested for the product is a waste.

Thinking of medical device acceptance, resistance, underuse, overrides, sabotage or non-use of technology/product becomes much more crucial. Because, nations around the world are trying to keep costs down, but strong incentives still exist for the development and use of new devices (Roback, 2006)

Technology acceptance models have been also used for medical devices and medical information technology to predict and explain end-user reactions. As mentioned before, rejection of product/technology affects companies negatively. Since research and development cost of new technologies is high, it is a risk to introduce new products. For this reason, companies want to understand if their technology will be used or not. At this point, an acceptance model is one of the predictive instruments for the companies.

On the other hand, researchers are interested in acceptance phenomenon in medicine. Kijsanayotin et al. (2009) employ a modified UTAUT structural model, to understand factors that influence CHC health IT acceptance in Thailand and to validate this extant IT acceptance model. Kohnke et al. (2014) studied on acceptance of healthcare telemedicine equipments. This study investigated the predictors of behavioral intention to use telehealth equipment by patients, clinicians, and agency personnel.

Yi et al. (2006) researched acceptance of personal digital assistants (PDAs) by healthcare professionals. They empirically examined the acceptance of telemedicine technology by physicians in Hong Kong.

5. METHODOLOGY

5.1 Research Model

In the light of the scanned literature, user acceptance models such as Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TBP) and Unified Theory of Acceptance and Use of Technology (UTAUT), UTAUT2 were examined in detail.

One of the most robust models is TAM which involves two main determinants of acceptance; perceived usefulness and perceived ease of use. Although it is easy to apply, the model is appropriate for voluntary usage. Since selected product and its usage scenario are appropriate for mandatory usage, TAM was not appropriate for the purpose of this study. On the other hand, among the existing models, the UTAUT2 model of Venkatesh et al. (2003), which is explained in detail previously (Section 2.2.1.5), was found to be comprehensive and up to-date in terms of its scope and usage. But similar to TAM, UTAUT2 is also appropriate for personal usage and voluntariness is necessary for the model. Consequently, there are three main reasons of the selection of UTAUT as the research model:

- It is one of the recent models in the literature.
- It is applicable for both voluntary and mandatory usages.
- It includes the most common constructs of eight prior models.

5.1.1 Data collection

As an exploratory study, interviews and questionnaire are used as data collection methods for the survey.

5.1.1.1 Interviews

The aim of making interview is to obtain users' subjective judgements about the sample product. Users see and use the product first time. During the user-product encounter, users are requested to evaluate the product and its usage. After the trial period unstructured interviews are held with users. The unstructured interview

specifically aims to capture users' very first ideas about their expectations regarding the usage of introduced product.

The interview is guided through open ended questions like:

- What are your general opinions about the product?
- Can you compare this product with the ones you used before?
- What are positive or negative properties of the product?

Where necessary, the questions are narrowed down spontaneously because of the characteristics of unstructured interviews.

Some of these questions are also in the survey questionnaires that were given to users after trial period.

5.1.1.2 Questionnaire design

According to Saunders et al (2007, s. 355), the questionnaire is a widely used data collection technique in survey research strategy, which best suits with descriptive and explanatory studies. Therefore, questionnaire is chosen as one of the data collection method of this study.

The main instrument of the survey is a paper-based questionnaire for each user. The questionnaire includes a combination of open-ended and close-ended questions. There are two open-ended questions, which aim to get detailed information from users. Saunders et al (2007, s. 369) states that, although the open-ended questions are useful to capture deeper knowledge, they are extremely time consuming to code and it is advised to keep their use to a minimum. Therefore, rests of the questions in the questionnaire were worded as closed-ended. Besides the survey was conducted in health offices, it was important to limit study duration.

There are five sections in the questionnaire. First section tries to understand demographic characteristics of users, second section tries to research experiences about sample product or similar ones, third section is consist of UTAUT measures and one more independent variable added to the model, fourth section tries to capture keywords about researched product by doing a comparison with any other similar product, fifth and the last section questions general ideas of users about selected product.

The core part of questionnaire is third section in which UTAUT questions are placed. There are 34 items to be evaluated by five point Likert-scale. Respondents are asked to rate each item on the scale; where "1" refers to "completely disagree" and "5" refers to "completely agree".

Data analysis of questionnaire was done with SPSS v.20 and Microsoft Excel 2013. With the SPSS v.20 regression analysis was done with variables of the research model to understand relationships among the variables.

To sum up, the survey was conducted in Turkish, which is the native language of all the users. The interpretations were done regarding the tense used in (constructing) the items. Since the users were going to see the product for the first time, scale items were in a combination of future and simple present tenses (Venkatesh et al., 2003). Original items were used directly without any modification except from the necessary interventions for the sake of interpretation.

UTAUT based questions of the questionnaire

As mentioned before, UTAUT was formulated with three determinants of behavioural intention; *performance expectancy*, *effort expectancy*, *social influence* and one direct determinant of use; *facilitating conditions*. Additionally, there are four moderators of the model: *gender*, *age*, *experience*, and *voluntariness* of use (Venkatesh et al., 2003).

One of the differences between UTAUT and this survey is the role of behavioural intention. UTAUT takes system usage as the dependent end-variable, but this study takes behavioural intention as the dependent end-variable. Since medical device usage is mandatory for the health personnel, users' behavioural intentions are accepted as the determinants of their future usage.

Second difference between UTAUT and this study is the effects of anxiety and self-efficacy on behavioural intention. Studying in medical context, effects of anxiety and self-efficacy are questionable. Similarly, while constructing UTAUT, Venkatesh et al. (2003) also questioned the effects of anxiety and self-efficacy. Finally they formularize UTAUT without anxiety and self-efficacy. They stated that anxiety and self-efficacy are not direct determinants. They have been modelled as indirect determinants of intention (Venkatesh, 2003).

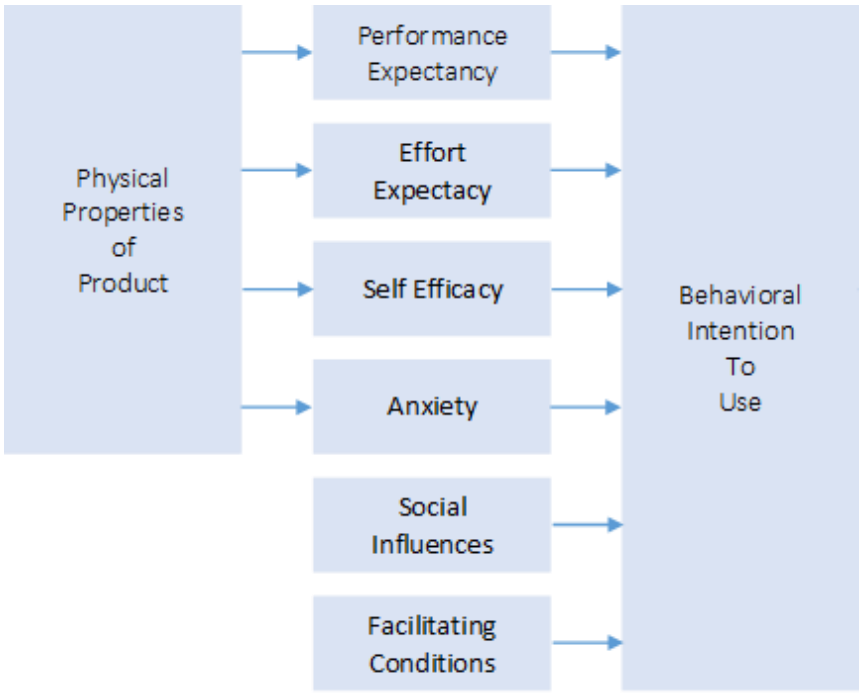

Figure 5.1 : Research Model

Third difference between this study and UTAUT is the one added independent variable, namely *physical properties of the product (PPoP)*. Simsek (2008) has added this variable to her study for searching acceptance of selected products in military context. Studying on a specific product, this independent variable is also added to the research model of this study Figure 5.1. Questions of added variable are as following: "*Thinking of its purpose and usage context; (1) The form of the device is appropriate, (2) The color of the device is appropriate, (3) The material of the device is appropriate, (4) The general form of the device is appealing, (5) Display of the device is in appropriate size"*, and "*(6) Display of the device is legible"*.

In this study, users' feedbacks about physical characteristics of the researched product are significant, because research and development phase is still continuing for the sample product. Besides, positive or negative critics about hardware and software design can be a contribution for the project and the project team.

Additionally, age, gender and voluntariness of use moderators are excluded from this study. Because, this study aims to get information about the effect of physical properties of the sample product, performance expectancy, effort expectancy, self-efficacy, anxiety, social influences and facilitating conditions on behavioural intention to use sample product in the future.

5.1.2 Population and sample

With respect to studying on a medical product, it is difficult to try selected product on a large number of people. It is crucial to get permissions from ethical committee of the hospitals. Without the permissions, it is not possible to study with patients and health personnel or to get samples from hospitals. For this reason, before the research and development phases ethical committee permissions should have been taken.

Target user group of chosen product were medical sector personnel, especially possible users of bilirubinometer. For this reason, a hospital was chosen around Anatolian region of Istanbul. After that, for getting permission for the study, application was done to the ethical committee. In this study permissions are taken by TÜBİTAK.

20 users were agreed to participate for the survey. User group is consisting of doctors, nurses and medical officer, who can be possible users of studied product. Users' reactions towards newly designed medical product are important in terms of predicting the real usage and the success of the product.

5.1.3 Product chosen to be used in the study

The sample product used in this study is a non-invasive hand-held bilirubin assessment device, namely SOBE (Figure 5.2), (Figure 5.3).

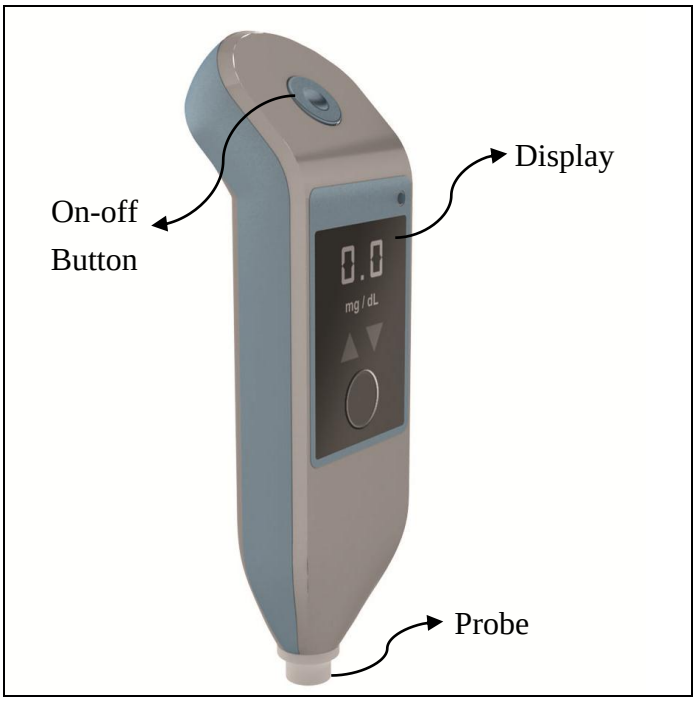

Figure 5.2 : Industrial design of SOBE (TÜBİTAK)

Figure 5.3 : SOBE and its usage (TÜBİTAK)

SOBE is a non-invasive hand-held bilirubinometer newly designed at The Scientific and Technological Research Council of Turkey (TÜBİTAK). Developing a hand-held bilirubinometer is a part of National Biomedical Device Development Project at TÜBİTAK. SOBE is designed for measuring bilirubin levels from newborns' skins without any invasive parts. Newborns' bilirubin assessment is crucial especially in early hours after the birth. But in most cases, monitoring the bilirubin level can be adequate information for doctors. According to the result, doctors can take different actions for preventing any unintended consequences.

Figure 5.4 shows main screen of SOBE. TÜBİTAK also develops user interface of SOBE. Usability of both the device and its interface is important for researchers.

Figure 5.4 : Interface of SOBE (TÜBİTAK)

Being a research council, one of the future facilities of TÜBİTAK is developing national medical products. It gives the start by biomedical products like transcutaneous device. Both software and hardware design of it is being developed at TÜBİTAK. Moreover, acceptance of newly developed medical products is questionable. For this reason, SOBE is selected as the first product to work on.

On the other hand, being in the design phase every positive and negative feedback is essential both for this study and future works in the project at TÜBİTAK. However, there are some shortages of the used material in this study. Being prototype, technical capabilities of selected product are unrefined that hinders its full performance capacity during trial. Although the users are informed about these shortages, they might have been affected by the users' evaluations.

5.1.4 The conduct of the survey

The study was conducted in Semiha Şakir Maternity Hospital (Figure 5.5), which is a part of Dr. Lütfi Kırdar Kartal Eğitim ve Araştırma Hastanesi (Figure 5.6) in İstanbul, and TÜBİTAK Health Office where the users are employed.

The management of the hospital was informed before the study. Moreover, permissions have been taken from the ethical committee of the hospital. The research has tried to be done during participants' usage at their office.

Figure 5.5 : Semiha Şakir Maternity Hospital

Figure 5.6 : Dr. Lütfi Kırdar Eğitim Araştırma Hastanesi

The study took place nearly two workdays; nearly sixteen hours. At beginning of every session, the author made a speech about the intention of the study after introducing herself.

5.1.4.1 User sample

The user sample consists of 20 health personnel. User sample covers both experienced and inexperienced users of transcutaneous bilirubinometer. 10 of them were doctors, 9 of them were nurses and 1 of them is medical officer.

5.1.4.2 Environment

The room where the users are introduced and discussions are done is the room of head of newborn unit in Semiha Şakir Maternity Hospital. She offered that her room can be used for the study. 2 tables, 4 chairs and a couch for 2 people were available. The layout of the room can be seen in the Figure 5.7.

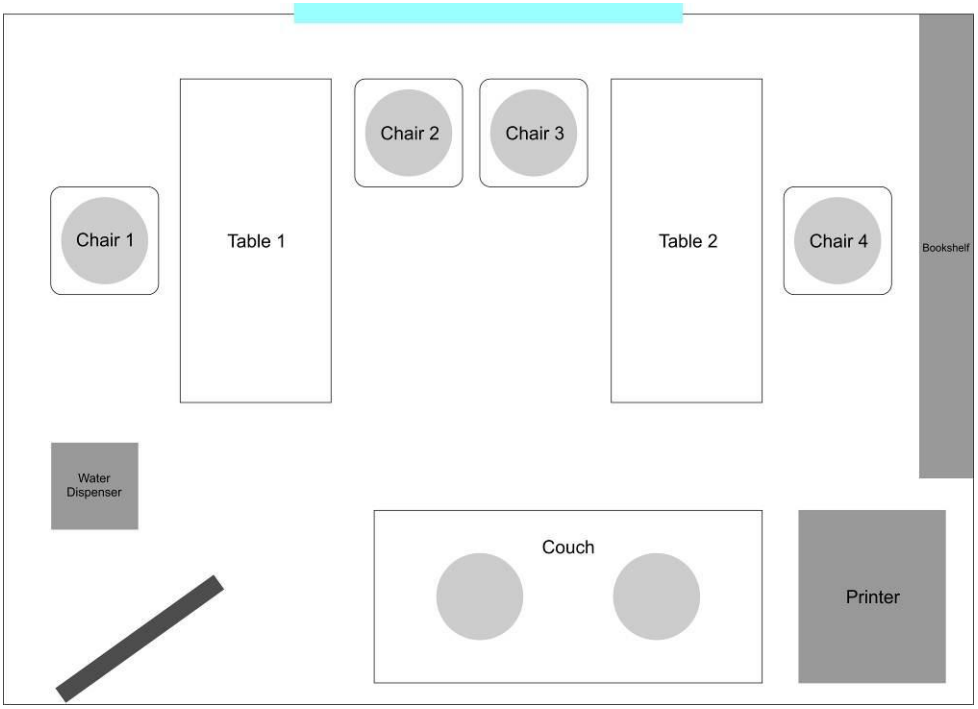

Figure 5.7 : Room layout where the study done in Semiha Şakir Maternity Hospital

5.1.4.3 Procedure

At first, a brief description of the procedure, its objective and related product is introduced to the users. They are requested to use and evaluate the product for about two or three minutes. Usage scenario is as following:

a. Power on the SOBE

b. Make a bilirubin assessment

c. Power off the SOBE

Sample product was first prototype that has limited usage. For this reason users were wanted to pass a three step usage scenario. Users are allowed to ask questions about the product at any stage of the test procedure.

Secondly, a short unstructured interview was done in order to obtain users' subjective evaluations of the product. It is planned to ask following questions:

- What are your general opinions about the product?
- Can you compare this product with the ones you used before?
- What are positive or negative properties of the product?

But in hospital environment, health personnel's time is valuable since they are waited by patients. During the interviews, especially doctors could not give detailed answers to the questions because they are announced by patients. For this reason short and fast interviews were done. Average time period for the interviews were two or three minutes. Moreover, spontaneous questions were asked to get clues about the usage and properties of the sample product. Audio-video data recording was not allowed. Thus, main arguments were note down on paper.

Finally, each user was asked to fill a paper based questionnaire. As mentioned before, questionnaire consisted of five parts. The form can be found in the Appendix A both in native and English versions.

In the next Chapter, the results of aforementioned survey study will be explored and the findings of the study will be discussed.

6. FINDINGS AND DISCUSSIONS

In this Chapter, the results of the survey study will be explored. The statistical findings will be analyzed regarding the interviews and paper-based questionnaires respectively. Then, the statistical results will be discussed with reference to the findings of literature review study.

6.1 Results of the Unstructured Interviews

The raw data gathered from unstructured interview is the users' personal statements about the SOBE and its usage. The statements of the users during the interview were noted down and these statements are analyzed.

6.1.1 General ideas about the SOBE

At the beginning of the unstructured interviews, users try to use the sample product. All the users passed three step usage scenario. All of them power on the SOBE, then make a bilirubin assessment and then power off the sample product.

During and after that usage scenario, questions seek the answers of general idea about the SOBE. 18 of 20 users have positive statements about the sample product, because there is a need for transcutaneous bilirubinometer in hospitals and clinics where newborns are treated. And, when the product is first introduced, users show their pleasure to researchers. One user's statement is:

> *"I have never heard about this kind of product. But it is a great idea!"*
>
> *"I like the product as we can measure baby's bilirubin level while they are sleeping. Using injection irritates them so much; also I don't like awaking them up."*
>
> *"It reduces infection risk both for us and babies."*

Users stated both positive and negative ideas about the SOBE. One of the nurses stated her pleasure to the research and said that:

"Newborns feel anxiety at their very first hours after the birth, measuring their bilirubin without invasive things is so good."

Every idea is very valuable for the research. As being very first prototype, SOBE will be developed according to the critics. For example one of the doctor's statements was:

"Will be a bag for carrying? If there is no, it will be lost."

Moreover especially experienced users on bilirubinometer have recommendations about the SOBE. For instance one user said that:

"I think you should protect the probe. Since, it is the most sensitive part of this product."

Probe is the part of the sample product that touches skin of baby and makes bilirubin assessment. Probe of the SOBE is crucial part of the product. Therefore, it should not harm or irritate the baby. On the other hand, probe is the part that makes measurement, users should be aware of its sensitiveness. Since, measurement results can be affected by misusages.

6.1.2 Users' subjective evaluations in the context of UTAUT

Most of the users' comments are positive in terms of usage, ergonomics and design of SOBE. When statements are categorized in the context of UTAUT, especially **performance** and **effort expectancy** constructs are the most significant subjects. For instance, some statements are below:

"This is great idea, congratulations to you! We need this product so much. We can measure babies' bilirubin level more quickly." (PE)

"This is a useful device." (PE)

"It is very useful not to inject baby for getting his/her blood, every time we need to check bilirubin level." (PE)

These comments emphasize the usefulness of the researched product SOBE. The terms "usefulness" and "quick" are keywords that **performance expectancy** can be traced. UTAUT states that performance expectancy is one of the most significant construct that shows behavioral intention to use a system or a product.

On the other hand, there are some clues for the **effort expectancy** construct. Effort expectancy is also significant for observing behavioral intention. Users' statements that effort expectancy can be traced are:

"I can easily use this product." (EE)

"Cord of the product is useful to me. With this cord it is easy to carry the device. I can even hang it on my neck or carry with my wrist." (EE)

"It isn't complex." (EE)

Comments show that users can easily use the SOBE. Therefore, the easier a product is the more people use it. Satisfied effort expectancy affects behavioral intention and product acceptance in positive way.

The ease of the product usage is related with the consequent user performance. In TAM, Davis (1989) states that perceived ease of use partially explains attitude by means of perceived usefulness. It is also consistent with the findings of UTAUT and modified versions of it; that in most cases, the effect of performance expectancy on attitude or intention to use was found to be stronger especially through time and gained experience.

The users' evaluations of SOBE sometimes moderated by means of the products' **advantage** or disadvantage with regard to existing bilirubinometer. **Effort expectancy** is the most important factor evaluated through **relative advantage**. Users make comparison with the product they use.

At Semiha Şakir Maternity Hospital, as a jaundice meter Draeger JM-103 is being used. When users compare research product and JM 103 below statements are declared.

"Draeger slides in my hands, this product does not! I like it."

With this comment industrial design of the SOBE is found to be convenient by the user. This user liked the product and declared her intention to use the SOBE.

"SOBE is a bit heavy when I compare it with Draeger."

Although sample product is the first prototype of SOBE, one user said that it is heavier than Draeger. Sample product's weight is perceived heavier because of the battery. This comment gives a clue to development of the product and its battery.

Another statement of one user is about display size. She said that:

> *"Draeger's display is smaller than SOBE. It is useful for us to see the result in a larger display, because we are always in a hurry and we do not tolerate mistakes"*

Being a mobile medical device, operating time is crucial for users. According to experienced bilirubinometer users, sometimes it takes two or three hours to measure all the babies' bilirubin level. Therefore, they do not want to think about the battery.

> *"Draeger's battery finishes quicker than SOBE."*
>
> *"We should power off JM 103 after some usage, its battery is not sufficient"*

Users were **anxious** about **reliability** of the measurements of the product, since accuracy of measurements is important both for users and patients. And health personnel first questions and feels anxiety about the results' reliability. One user asked below question, which shows his anxious about the reliability of product.

> *"Can I trust results of this product?" (REL.)*

Moreover, users feel **anxiety** about the **physical properties of the researched product**. Also this anxiety is related to the research area. Being a medical device, hygiene is one of the inevitable features to consider. Two users commented about the cleanliness of the SOBE.

> *"I have questions about cleanliness of the product connection parts." (ANX)*
>
> *"It will be more hygiene when there is no connector opening. Because we use this products several times in a day, and it is inevitable the openings to get dirty" (ANX)*

Another user stated that:

> *"I have one hesitation about the cleanliness of the probe. Because it will touch the skin of the baby" (ANX)*

Users' expectations and beliefs about the **facilitating conditions** and social influences are very rare during the interviews. For experienced users, who already know how to use a jaundice meter, SOBE is not a complex device to use and there is no need for facilitating conditions. Also, they compare SOBE with lots of other

complex medical devices and therefore it is evaluated as a basic device in that environment. One statement is:

"Probably, I don't need help menu, this device is very easy to use." (FC)

Regarding the effect of **social influence**, users' answers are changing according to their profession. Effect of social influence on nurses is more noticable than doctors. In health profession, seniority is as important as in military. For this reason for juniors, social influence is more effective than superiors. One experienced doctor stated that:

"During the usage of SOBE no one can influence me, because I can use it in every condition. In here, we are dealing with people's health. Any other small issues do not affect me!" (SI)

This comment can be declared by superiors. Since they are responsible for more important issues like saving one's life, they do not think of what others think for themselves.

On the other hand, social influence is the fact that is more visible for nurses and other health personnel than doctors. Moreover, juniors feel social influence on themselves that they should do given jobs by superiors. They work according to the doctors' decisions about the patients. For this reason, they have relatively less responsible for critical decisions but their every action is under control by doctors in one sense. One doctor said that:

"I do not use blood pressure cuff, the nurse measures it and informs me about the result."(SI)

One of the nurses said that,

"I should use SOBE, because doctor wants me to use it properly." (SI)

Self-efficacy of doctors, nurses and other health personnel has similarities with social influence. As can be seen from the personal statements, self-efficacy of doctors is higher than nurse. Doctors believe that they have capacity to work with new medical devices. They have higher self confidence in working with new technology. This is also related with being junior or superior in a hospital. Self-efficacy seems to be influential on users' **behavioral intention**. Because when self-

efficacy is high or positive, they can easily adapt to the new product and intent to use it.

Lastly, the effect of **physical properties of the product** on users' has a correlation with effort expectancy. Many of the users evaluated the product form in terms of its ease of use.

> *"It fits to hand, at least my hand! I find the product ergonomic."*
>
> *"I like placement of on-off button, I can easily use it."*
>
> *"It doesn't slide in my hands like the other brand, I can easily hold it."*

Being one of the physical characteristics of the product, users also comment on screen size, its usability and legibility.

> *"Product's display size is so convenient, but I don't sure about the background color."*
>
> *"Contrast of the display color can be increased."*

Statements show that, physical characteristics of the product have an influence on users' effort expectancies.

6.2 Analysis of the Questionnaire Results

As previously presented, after an unstructured interview, the survey conductor wanted the users to fill in the questionnaire. IBM SPSS v.20 and Microsoft Excel 2013 were used for analysis of the questionnaire.

6.2.1 Section a: demographic information of users

This study was done with 20 users. Age of the users vary between 24 and 53. As it can be seen from the Figure 6.1, 1 user is less than 25 years old, 5 of 20 users are between 25-29 years, 3 users are between 30-34 years, 4 users are between 35-39 years and 7 of 20 users are over 40 years old.

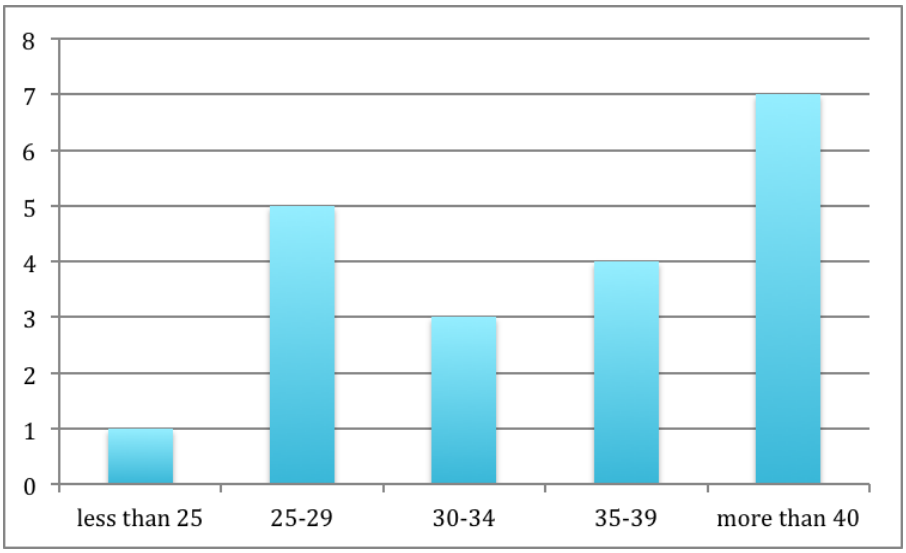

Figure 6.1 : Age distribution of users

On the other hand, users' gender distribution is shown in the Figure 6.2. 5 users are male and 15 are female.

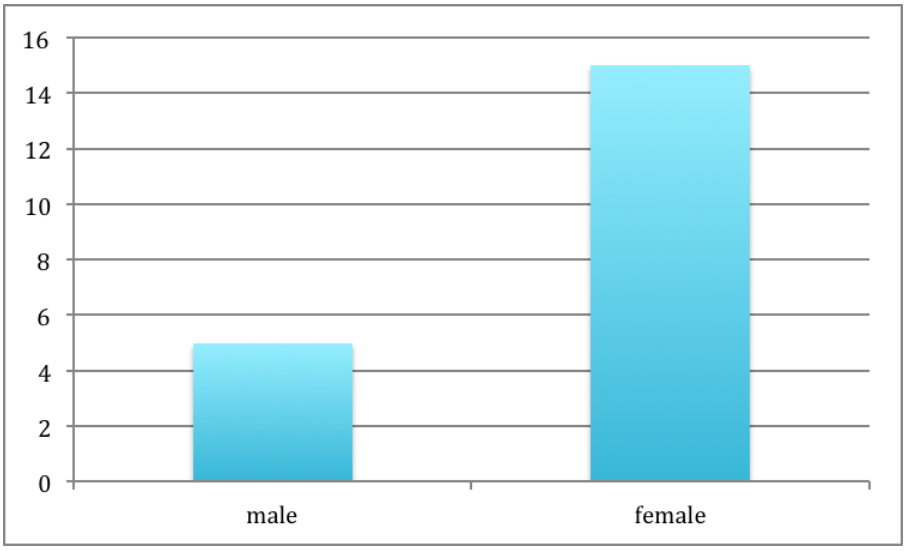

Figure 6.2 : Gender distribution of users

Being related with context of the survey, it was done with health personnel. Their professions can be seen in the Figure 6.3. 10 of the users are doctors, 9 of them are nurses and only one of them is medical officer.

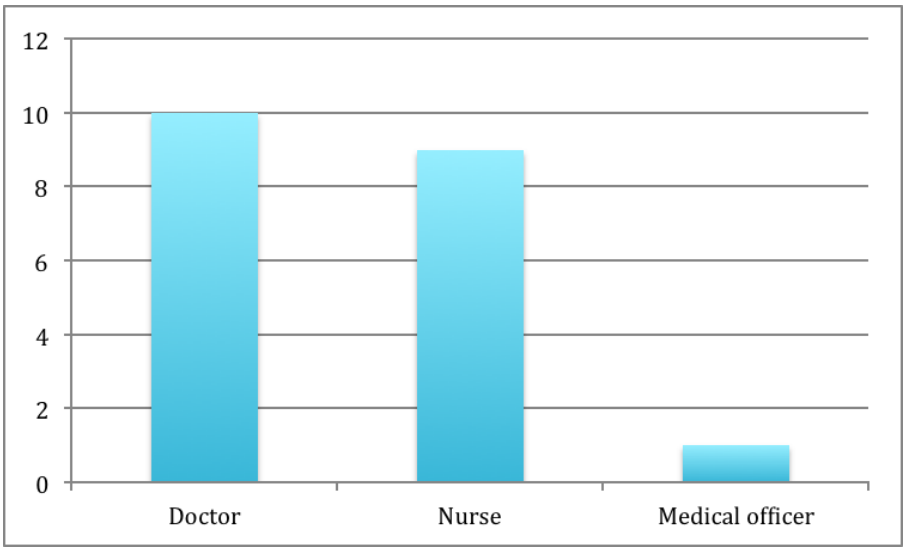

Figure 6.3 : Professions of users

Figure 6.4 shows that 2 of the users have high school degree, 10 of the users have bachelor degree, 7 of them have masters' degree and 1 user has PhD degree.

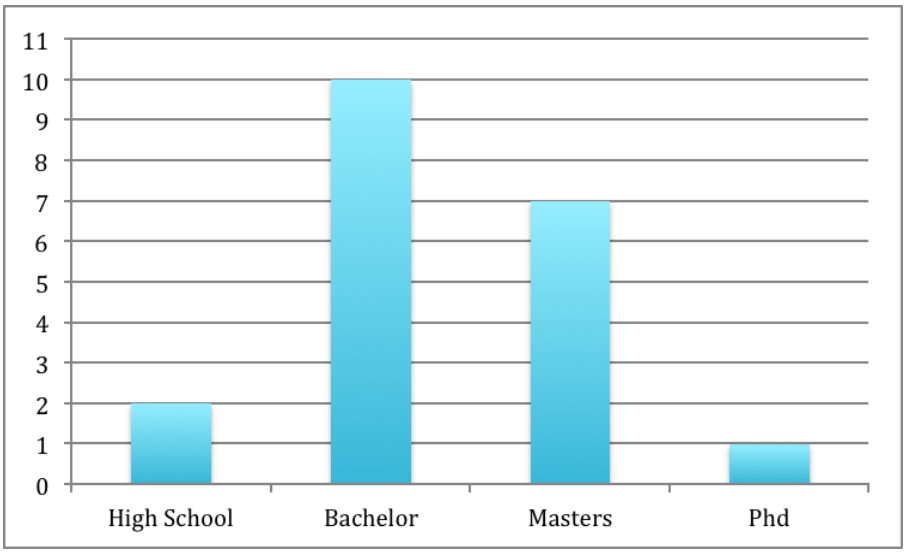

Figure 6.4 : Education level of users

6.2.2 Section b: general evaluations about medical device usage

With section B of the questionnaire, it is aimed to understand users' experience with hand-held medical devices. Moreover, experienced users with transcutaneous bilirubinometer is observed and analyzed.

Figure 6.5 shows that users are experienced in hand-held medical devices. Because in a hospital there are many medical devices used by doctors, nurses and other health personnel. For this reason, medical stuff is used to use both hand-held and

freestanding devices. As it can be seen from the Figure 6.5, blood pressure cuff, pulse oximeter and glucometer are the three devices mostly used by users.

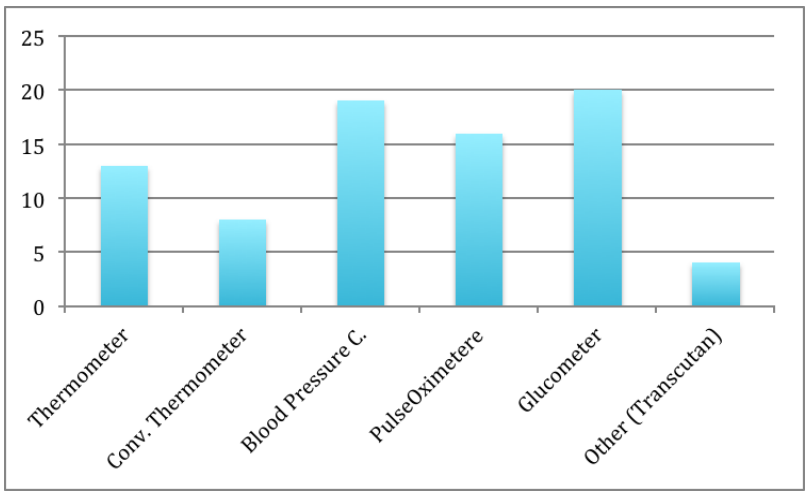

Figure 6.5 : Frequency of hand-held medical devices used by users

Users' experience with transcutaneous bilirubinometer can be seen from the Figure 6.6. Half of the users have experience in using transcutan and half do not have.

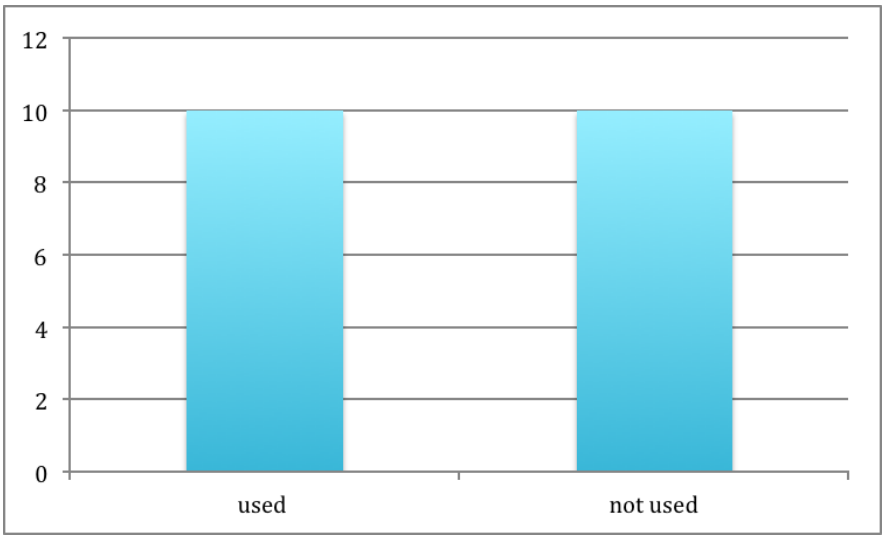

Figure 6.6 : Number of experienced users with Transcutaneous Bilirubinometer

Although 10 users are not experienced in using transcutaneous bilirubinometer, 8 of them evaluate themselves as non-user (Figure 6.7). 2 of users think that they are beginner user of SOBE even they do not use it. According to statements of these two users, this is because of their familiarity of lots of medical devices. Besides, 5 users see themselves as intermediate user and 5 of them are advanced users in using transcutan.

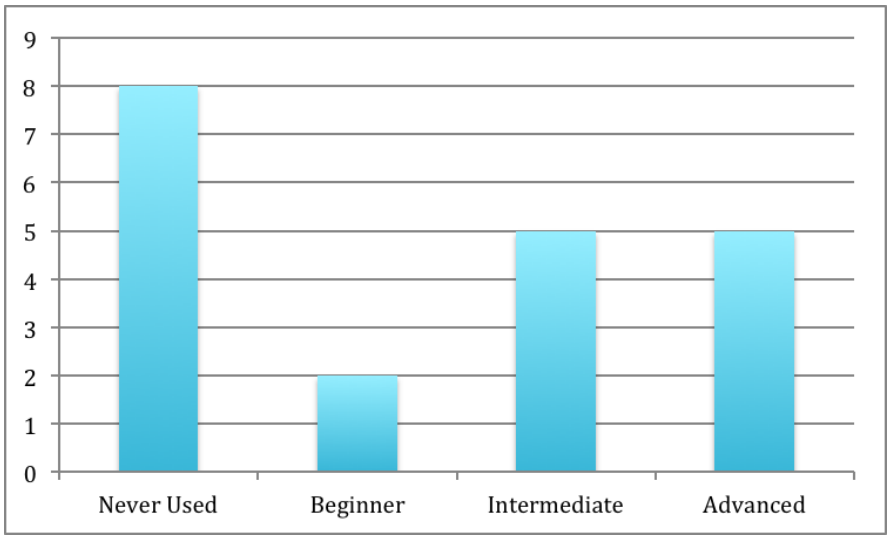

Figure 6.7 : Level of transcutan usage

6.2.3 Section c: evaluations about SOBE with UTAUT

Section C of the questionnaire contains questions about SOBE and these questions are defined by UTAUT model. Moreover there are some additional questions about physical properties of SOBE.

There are some noteworthy findings from the results of the regression analysis, which is shown in the Table 6.1. In the table the rows painted in the dark indicate the meaningful effects of independent variables on the dependent variable. R^2 values indicate the overall significance of the independent variables in explaining the change in the dependent variable.

In the first four rows, the effect of independent variable; *Physical Properties of the Product* (PPoP) on the dependent variables; performance expectancy, effort expectancy, anxiety and self-efficacy is evaluated separately. Here, it is tried to understand whether physical properties of the new products affects new product acceptance. According to the findings, there is a meaningful relationship between PPoP and performance expectancy with 17%, between PPoP and effort expectancy with 19% and between PPoP and anxiety with 9%. It shows that, 17% of change in performance expectancy, 19% of change in effort expectancy and 9% of change in anxiety can be explained by the change of PPoP. On the other hand, PPoP has no meaningful effect on self-efficacy.

Dependent Variables	Independent Variables	Beta	R2
Performance Exp.	Physical Properties of the Product	0.422***	0.178
Effort Exp.	Physical Properties of the Product	0.436***	0.19
Anxiety	Physical Properties of the Product	(-).309***	0.096
Self Efficacy	Physical Properties of the Product	0.002	0
Behavioral Intention	Performance Expectancy	0.625***	0.707
	Effort Expectancy	0.178	
	Social Influences	0.157	
	Facilitating Conditions	0.149	
	Self Efficacy	0.083	
	Anxiety	(-).535***	
	EXP	0.052	
Behavioral Intention	Performance Expectancy	0.526***	0.438
	Effort Expectancy	0.145	
	Social Influences	0.261*	
	Facilitating Conditions	0.18	
Behavioral Intention	Performance Expectancy	0.597***	0.412
	Effort Expectancy	0.187	
	Social Influences	0.319*	
Behavioral Intention	Performance Expectancy	0.523***	0.388
	Effort Expectancy	0.047	
	Facilitating Conditions	0.258	

***Correlation is significant at the 0.01 level (2-tailed)
**Correlation is significant at the 0.05 level (2-tailed)
*Correlation is significant at the 0.10 level (2-tailed)

Table 6.1 : Results of regression analysis

The most significant finding of the results is that the original UTAUT model was not fully validated as it can be seen from the sixth row of the Table 6.1. Because according to UTAUT performance expectancy, effort expectancy, social influence and facilitating conditions have meaningful effects on behavioral intention. Research results show that, effort expectancy and facilitating conditions have very small effect except from performance expectancy and social influences.

The effects of independent variables of this study on behavioral intention are also evaluated in the fifth row of the Table 6.1. Here results are slightly different from sixth row. But the main thing is, performance expectancy is the most important variable that explains variance in behavioral intention. Other important finding of

this research is, however original UTAUT model excludes anxiety from the model, in this study anxiety affects behavioral intention meaningfully. Moreover, when result of UTAUT is compared with subjective evaluations of users, there is a contradiction about anxiety variable.

It is remarkable that, in the analysis of model, the effect of user experience was insignificant. Fifth row of the Table 6.1 shows that, experience has almost no effect on behavioral intention. Besides, during the interviews, inexperienced users are more interested in using SOBE. Furthermore, because of the lack of this kind of medical device, they want it to be accepted by hospital managers more than experienced users.

6.2.4 Section d: results of keyword selection about SOBE

D section of the questionnaire aims to capture keywords from users about SOBE and its usage. Keywords are chosen both from the UTAUT questions and possible words that can be used when evaluating a product.

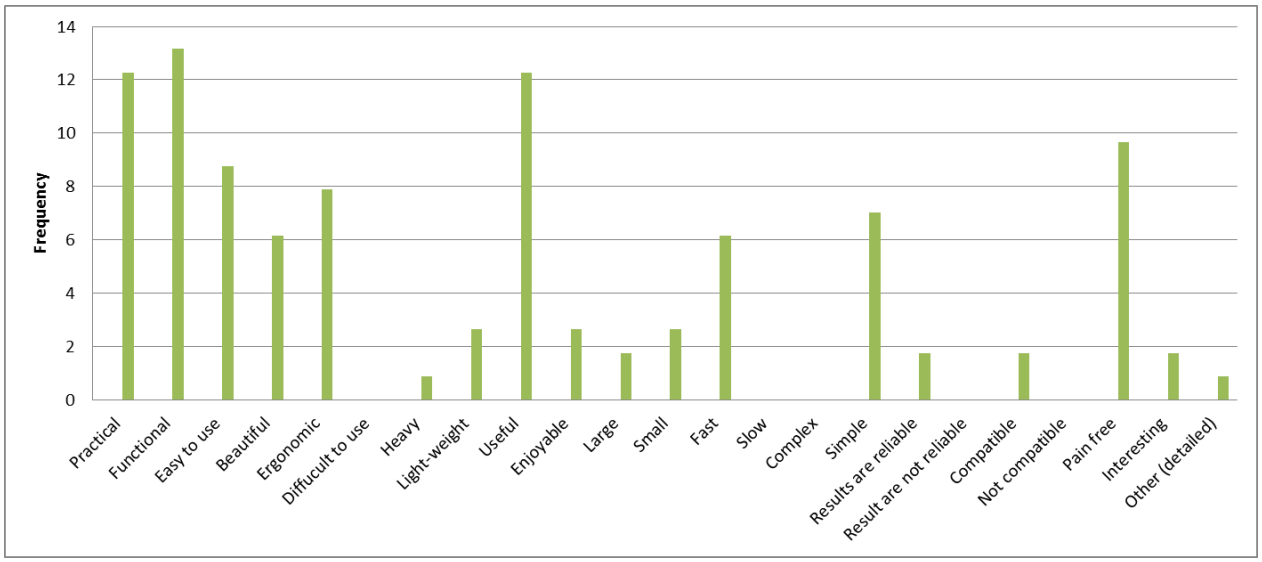

Figure 6.8 : Frequency of selected keywords by users

As Figure 6.8 shows, there are 22 different keywords in the questionnaire and 1 "other" answer that the users feel free to write additional keywords. Most of the users selected positive keywords for evaluating SOBE. The most preferred ones are; *practical* (with 12,2%), *functional* (with 13,1%), *useful* (with 12,2%) and *pain free* (with 9,6%). Besides, *easy to use* (with 8,7%), *ergonomic* (with 7,9%) and *simple* (with 7%) are also noteworthy.

Frequency of two selected negative keywords are; heavy (with 0,9%) and large (with 1,7%). On the other hand, difficult to use, slow, results are not reliable and not compatible are not selected by any of the users.

6.2.5 Section e: general thoughts about survey/SOBE

Section E aims to get deeper thoughts about the survey or SOBE that could not be declared during the interviews or with the questionnaire. 5 of 20 users answered this open-ended question. One user states that:

"…it should be studied more"

On the other hand, another user's statement is:

"It will be very useful to monitor bilirubin levels of newborns."

One user answered the question by one word:

"Want it!"

Although it is aimed to get detailed comments, 15 of 20 users did not answer the question. Moreover, answered ones are not detailed as they are expected.

6.3 UTAUT and Medical Device Acceptance

This study tried to make a user research for a medical device based on UTAUT. By doing this both interviews and questionnaire made contribution to the study. But the results show that original UTAUT model is somehow deficient to explain product acceptance in health context.

In order to better understand the results, the study measures will be analysed separately.

Physical Properties of the Product

Studying on product acceptance, physical properties of medical devices was proposed to be affective on users' performance expectancy, effort expectancy, anxiety and self-efficacy. Questionnaire results proved that physical properties of product is effective on users' performance expectancy (18%), effort expectancy (19%) and anxiety (10%), whereas it is not effective on self-efficacy. Users do not relate self-efficacy with the form of the product. According to these result, the form, color, material, display size, color and legibility of display have effects on performance expectancy, effort expectancy and anxiety.

Subjective evaluations of users also show that physical properties of the product affect their performance and effort expectancies. Contrary to questionnaire results, users have not mentioned any anxiety statement about the form of the product.

Performance Expectancy

Questionnaire results proved that the most significant variable on product acceptance is the performance expectancy. Behavioural intention to use the new medical product is explained with 28% in variance by performance expectancy. Therefore users think that using this product would enhance their job performance.

On the other hand, there are noteworthy performance expectancy related evaluations that will positively affect behavioural intention. This finding is in accordance with the questionnaire results of the survey and also original UTAUT model.

Effort Expectancy

The most significant finding of the questionnaire result is that the effort expectancy has very small effect on behavioural intention. Although UTAUT considers effort expectancy one of the most important variables on behavioural intention, questionnaire results of this study cannot find meaningful effect that the original model proposed.

Contrary to questionnaire results, personal statements of users show that there is a strong relationship between effort expectancy and behavioural intention. Users' statements are mostly about ease of use. Also effort expectancy related keywords are the most selected ones by users.

Social Influence

Social Influence has meaningful effect on behavioural intention. Both questionnaire results and personal statements of users prove the original model's proposal. Especially juniors are much more affected from social influences. Working in hospital environment, making mistakes is not acceptable and they are under control by superiors.

Facilitating Conditions

Facilitating Conditions is found insignificant in terms of users' behavioural intention to use the product. This finding is also different from original model's proposals. Because according to UTAUT, facilitating conditions play important role in product

acceptance. However, this study does not reveal such a result. Both questionnaire results and personal statements show that facilitating conditions have no meaningful effect on medical product acceptance. Moreover, according to users' subjective evaluations, working with a lot of complex devices, using SOBE is easy to use and there is no need for extra help or any support.

Anxiety

As it is expected by the research model of this study, anxiety has negative effect on behavioural intention. Both questionnaire results and personal statements proved the proposal of the model. Although original UTAUT excludes anxiety variable from the model, for medical context, it should be taken in consideration. Being crucial for medical context, reliability of new technologies and products create anxiety on users.

Self-Efficacy

Questionnaire results found that self-efficacy of users does not have an important effect on behavioural intention to use the product. This finding is in accordance with the UTAUT model, which states that the effect of self-efficacy is captured by the effect of effort expectancy.

Experience as Moderator

Questionnaire results do not display any meaningful effect of experience on users. Study was done both experienced and inexperienced users with the hand-held bilirubinometer. But, both questionnaire results and personal statements show that experience is not effective in product acceptance in medical context. This can be explained by their familiarity of lots of medical devices, which are more complex and risky.

7. CONCLUSION

In the light of research question of this study, factors that influence new product acceptance in a hospital environment have been researched. Sociology, information technology, acceptance, usability, management and health technologies literature contribute this study. At the beginning of the study, technology acceptance phenomenon and related theories are summarized, usability is described as a dimension of acceptance and health technologies are introduced. Then methodology of the study is explained and then research results are given in detail.

There are significant findings of this study. According to the exploratory research study results, product acceptance is different in health context in some perspectives. Firstly, being the most crucial thing for a person, thinking of health related technologies and devices should be considered apart from other consumer products. Innovations about healthcare serve medical sector a lot and their main purpose is to reduce errors, increase safety and quality. For this reason acceptance of a medical device begins with the question of reliability. Health personnel feel anxiety mostly about reliability of the results of the new products. This is because, they are curious about the effects of new technologies results on patients.

According to both unstructured interview and questionnaire results, product acceptance in medical context is mostly related with performance expectancy of users. Since, health care benefits from new devices and technologies for monitoring, diagnosing, preventing and treatment, health personnel want to use any kind of devices that are useful for both patients and themselves.

Another finding of this study is that the health personnel are accustomed to use different types of medical devices. This is why they easily adapt and use new products.

Lastly, main constructs of technology acceptance models seem to be not effective in health context as they are assumed. According to the interview and questionnaire results, effort expectancy and facilitating conditions have no meaningful effect on behavioural intention to use the new product.

7.1 Limitations of the Study

This study has some limitations especially with its context. Being related with human health care, permissions from ethical committee of the hospital have to be taken before the research. It is not allowed to conduct the research in different hospitals because of these ethical issues. Moreover, the survey could not use audio-visual sources because of privacy of patients.

On the other hand, permissions were taken from one hospital's ethical committee by TÜBİTAK. In addition to the hospital personnel, TÜBİTAK health personnel also participated the research study. Although this contribution is made, the number of users is limited which may not be enough to make general statements for the whole users.

Lastly, the UTAUT questions may not be well understood by the users. Although translation is done according to the context, during the questionnaire session there are some questions about the UTAUT questions by the users.

7.2 Recommendations for Further Research

The purpose of this study is to make a user research and define factors that influence health personnel's new product acceptance. And with this study, existing acceptance models are analysed and selected model is tried to apply in medical context. But results show that applied acceptance model is deficient in explaining new product acceptance in medical context. Thus, this study is a contribution for further research in both acceptance theories and medical devices areas.

Since this study is conducted on one hospital's newborn unit, sample size is not adequate for making general statements. For the further study, number of users can be increased in order to evaluate sample product with large number of users.

Literature studies about product acceptance mostly focus on questionnaires that are evaluated by regression analysis. With this study, being related directly with person and health, personal evaluations are also given importance.

To conclude, this study is done with a prototype of developing medical device. Users' personal statements are about this prototype not the final full operated device. To validate the results and findings of the study, further research may measure actual usage with real product.

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APPENDICES

APPENDIX A: Questionnaire

1.Turkish Version

Bu anket İstanbul Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan bir tez kapsamında hazırlanmıştır. Ankette amaçlanan "Yenidoğanda transkutan bilirubin ölçüm cihazı"'nın kabul edilirliği hakkında bilgi toplamaktır.

Görüşleriniz gizli tutulacak ve sadece araştırma amacıyla kullanılacaktır. Eğer bir sorunuz olursa lütfen çekinmeyiniz. Katılımınız için teşekkür ederiz.

A. Kişisel Bilgiler

1. Yaş: .....
2. Cinsiyet: .....
3. Meslek: .....
4. Eğitim Seviyeniz:

☐ İlköğretim ☐ Lise ☐ Yüksekokul ☐ Üniversite ☐ Yüksek Lisans ☐ Doktora

B. Cihaz Kullanımı ile İlgili Genel Sorular

1. Hastanenizde kullandığınız el ölçüm cihazları hangileridir?

☐ Kulaktan Ateş Ölçer ☐ Civalı Ateş Ölçer ☐ Tansiyon Aleti

☐ Pulse Oksimetre ☐ Glukometre Diğer .....

2. En sık kullandığınız 3 cihazı, hangi sıklıkla kullanıyorsunuz?

Günde	.....kere
Haftada	.....kere
Ayda	.....kere

Günde	.....kere
Haftada	.....kere
Ayda	.....kere

Günde	.....kere
Haftada	.....kere
Ayda	.....kere

3. Hastanenizde bilirubin ölçüm cihazı var mı?

☐ Evet ☐ Hayır

4. Bilirubin ölçüm cihazını siz kullandınız mı?

☐ Evet ☐ Hayır

5. Kendinizi bilirubin ölçüm cihazını kullanmada hangi seviyede görüyorsunuz?

☐ Hiç kullanmadım ☐ Başlangıç ☐ Orta Seviye ☐ İleri

6. Bu cihazın kullanımını tarifeder misiniz?

C. Bu bölümdeki sorularda size en uygun cevaba (x) işaretini koyarak test ettiğiniz "**Yeni doğanda transkutan bilirubin ölçüm cihazı**" hakkında fikrinizi belirtiniz.

	KesinlikleKatılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	KesinlikleKatılıyorum
1. Cihaz, yeni doğanlarda bilirubin değerlerini ölçmek için **faydalı** bir ürün.					
2. Cihazı kullanmak, ölçümlerimi daha **çabuk** yapmamı sağlar.					
3. Cihazı kullanmak üretkenligimi artırır.					
4. Cihaz ile etkileşimim açık ve anlaşılır.					
5. Cihazı ustaca kullanmak benim için kolaydır.					
6. Cihaz **kolay** kullanılabilir.					

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
7. Benim için, bu cihazı kullanmayı öğrenmek kolay olur.					
8. Cihazı kullanmak iyi bir fikir.					
9. Cihazı kullanmak, işimi ilgi çekici yapar.					
10. Cihazı kullanmak eğlenceli.					
11. Cihazı kullanmayı sevdim.					
12. Davranışlarıma etkisi olan kişiler, cihazı kullanmam gerektiğini düşünür.					
13. Benim için önemli olan kişiler, cihazı kullanmam gerektiğini düşünür.					
14. Yöneticiler/müdürler, cihazın kullanımında yardımcı olurlar.					
15. Genel olarak, bağlı olduğum kurum cihaz kullanımını destekler.					
16. Cihazı kullanmak için gerekli kaynak var.					
17. Cihazı kullanmak için yeterli bilgim var.					
18. Bu cihaz, diğer kullandığım cihazlarla uyumlu **değil.**					
19. Cihaz kullanımı ile ilgili sorunlarda başvurabileceğim bir kişi ya da grup mevcut.					

	KesinlikleKatılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	KesinlikleKatılıyorum
Cihazı kullanarak bir işi yada görevi tamamlayabilirim, eğer;					
20. kullanırken ne yapacağımı söyleyen biri **olmazsa**					
21. zorlandığımda yardım için birini çağırabilirsem					
22. ölçüm yapmak için çok vaktim varsa					
23. cihazda yardım menüsü varsa					
24. Cihazı kullanıp kullanmama konusunda tereddütlüyüm.					
25. Cihazı kullanırken, yanlış bir şey yapacağım düşüncesi beni korkutuyor.					
26. Bu cihaz bir şekilde beni tedirgin ediyor.					
Kullanım amacı ve kullanıldığı ortam düşünüldüğünde;					
27. ürünün genel şekli uygun					
28. ürünün rengi uygun					
29. ürünün malzeme seçimi uygun					
30. Cihazın genel görünümü çekici					
31. Cihazın ekran büyüklüğü yeterli					
32. Cihazın ekranı okunaklı					
33. Yakın zamanda bu cihazı kullanmak isterim.					
34. Yakın zamanda bu cihazın temin edilmesi beni memnun eder.					

D. Daha önce kullandığınız cihazla karşılaştırma yapmanız gerekirse bu ürünü nasıl değerlendirirsiniz? (Birden fazla seçenek işaretleyebilirsiniz.)

☐ Pratik	☐ Kullanışlı	☐ Kolay	☐ Güzel
☐ Ergonomik	☐ Zor	☐ Ağır	☐ Hafif
☐ Faydalı	☐ Eğlenceli	☐ Büyük	☐ Küçük
☐ Hızlı	☐ Yavaş	☐ Kullanımı karmaşık	☐ Kullanımı basit
☐ Sonuçları güvenilir	☐ Sonuçları güvenilir değil	☐ Diğer sistemlerle/ cihazlarla uyumlu	☐ Diğer sistemlerle/ cihazlarla uyumlu değil
☐ Acısız	☐ İlginç	Diğer	

E. Genel/diğer görüşleriniz nelerdir?

Anketi tamamladınız.

Katılımınız için tekrar teşekkür ederiz.

2. English Version

This questionnaire is prepared as a part of the thesis at Istanbul Technical University. The purpose of this questionnaire is to get your opinions about "Transcutaneouos Bilirubin Assessment Device".

Your ideas and answers will not be shared by third participants. If you have questions please do not hesitate to ask. Thank you for your participation.

A. Demographic Information

1. Age: .....
2. Gender: .....
3. Profession: .....
4. Education Level:

☐ Primary School ☐ High School ☐ College ☐ Bachelor Degree ☐ Master's Degree ☐ PhD

B. Questions About Medical Device Usage

1. What kind of hand devices do you use in your hospital?

☐ Thermometer ☐ Conventional Thermometer ☐ Blood Pressure Cuff

☐ Pulse Oximeter ☐ Glucometer Other .....

2. How often do you use the most used medical devices?

In a day	.....times
In a week	.....times
In a month	.....times

In a day	.....times
In a week	.....times
In a month	.....times

In a day	.....times
In a week	.....times
In a month	.....times

3. Do you have bilirubin assessment device in your hospital?

☐ Yes ☐ No

4. Have you ever used bilirubin assessment device?

☐ Yes ☐ No

5. According to you, what is your level in using bilirubin assessment device?

☐ Never Used ☐ Beginner ☐ Intermediate ☐ Advanced

6. Could you describe the usage of bilirubin assessment device?

C. In this section there are statements about "**Trancutaneous Bilirubin Assessment Device".** Please put an (x) for the one that best represents your idea.

	Completely Disagree	Disagree	Neutral	Agree	Completely Agree
1. The device is useful for measuring bilirubin level of newborns.					
2. Using the device enables me to accomplish my Job more quickly.					
3. Using the device increases my productivity.					
4. My interantion with the device is clear.					
5. It would be easy for me to become skillful at using device.					
6. The device is easy to use.					

	Completely Disagree	Disagree	Neutral	Agree	Completely Agree
7. Learning to work with the device is easy.					
8. Using the device is a good idea.					
9. Using the device makes work more interesting.					
10. Using the device is fun.					
11. I liked using the device.					
12. People who influence my behavior think that I should use the device.					
13. People who are important to me think that I should use the device.					
14. My managers/superiors would be heplful in using the device.					
15. In general, the hospital supports the use of the product.					
16. There are resources necessary to use the device.					
17. I have necessary knowledge to use the device.					
18. The device is **not** compatible with other devices I use.					
19. A person or a group is available for assistance with the device related difficulties.					

	Completely Disagree	Disagree	Neutral	Agree	Completely Agree
I can complete a job using the device if...;					
20. there is no one around to tell me what to do as I go.					
21. I can call someone for help when I got stuck.					
22. I have a lot of time for bilirubin measurement.					
23. there is a help-menu in the device.					
24. I feel apprehensive about using the device.					
25. I scares me to think that I could lose information by hitting a wrong key.					
26. The device is somewhat intimidating to me.					
Thinking of it usage purpose and use context;					
27. the product form is appropriate.					
28. the color of the product is appropriate.					
29. the material selection is appropriate.					
30. the general looking of the product is appealing.					
31. display of the device is in appropriate size.					
32. display of the device is legible.					
33. I would like to use the device in the next few months.					
34. The procurement the device in the next few months would make me pleased.					

D. If you compare SOBE with the other ones you have used, how do you evaluate it? (You can choose more than one answer)

☐ Practical	☐ Functional	☐ Easy to use	☐ Beautiful
☐ Ergonomic	☐ Difficult ot use	☐ Heavy	☐ Light-weight
☐ Useful	☐ Enjoyable	☐ Large	☐ Small
☐ Fast	☐ Slow	☐ Complex	☐ Simple
☐ Result are reliable	☐ Results are not reliable	☐ Compatible with other systems	☐ Not compatible with other systems
☐ Pain free	☐ Interesting	Other	

E. What are your general/other ideas about the device?

You have completed the questionnaire.

Thank you for your time and contribution.

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