EXPLORATION OF USER EXPERIENCE OF PERSONAL INFORMATICS SYSTEMS

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ABSTRACT

EXPLORATION OF USER EXPERIENCE OF PERSONAL INFORMATICS SYSTEMS

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Many people use personal informatics systems to gather personal behavioral data, make better decisions, and make changes to their behavior. While the proliferation of new products on the market makes collecting personal data easier, how to help people engage with these systems over a long period of time remains an open question. To uncover which features of personal informatics systems lead to engaging experience and long-term use, two user studies were conducted with people who use personal informatics systems to support or track behavior change. Baseline interviews were conducted and participants were asked to interact with personal informatics systems. Participants rated their experience both qualitatively and quantitatively and particularly in Study2, participants rated their experience with the system daily. At the beginning and at the end of each study, participants were asked to reflect on their physical activity levels and on their perceived behavior change at the end of the each study. The results were analyzed qualitatively and quantitatively and similarities and differences between the studies were exhibited.

This research reveals that easy and instant access to data is critical, and feeling good and positive social outcomes of interaction will also support sustained product use. In addition, personalization of data is emerged to be an important expectation of the users. At the end, design implications for future personal informatics system are also offered.

Keywords: User experience, persuasive technology, personal informatics systems, behavior change through technology, user engagement

ÖZ

KİŞİSEL BİLGİ SİSTEMLERİNİN KULLANICI DENEYİMİNİN İNCELENMESİ

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Birçok insan, kişisel davranışları hakkında veri toplamak, daha iyi kararlar almak ve hedeflenen davranışı değiştirebilmek için kişisel bilişim sistemleri kullanmaktadır. Piyasada yeni ürünler çoğalıp kişisel verilerin toplanmasını kolaylaştırırken, kullanıcıların yaşamına uzun erimli bütünleşmeleri net değildir. Bu çalışmada, deneyim ve uzun erimli ürün kullanımını hangi ürün özelliklerinin sağlayacağını ortaya çıkarmak için, iki kullanıcı araştırması yürütülmüştür. Katılımcıları egzersize yöneltebilecek kişisel bilişim sistemlerinin kullanımı farklı yöntemlerle gözlenmiştir. Her iki çalışmada da ön görüşmeler yapılmış ve katılımcıların kişisel bilişim sistemleri ile etkileşimi sağlanmıştır. Katılımcılar, her iki çalışmada da, deneyimlerini sayısal ve sözel olarak değerlendirmiş, ikinci çalışmada sistem ile deneyimlerini günlük olarak puanlamıştır. Her iki çalışmanın başında ve sonunda, fiziksel aktivite durumlarına bakılmış ve çalışmaların sonunda algılanan davranış değişikliği anlaşılmaya çalışılmıştır. Tüm çalışma sonuçları, nitel ve nicel olarak analiz edilmiş ve ortak ve ayrışan yönleri ortaya koyulmuştur.

Çalışma sonucunda kişisel bilişim sistemlerinde, verilere kolay ve hızlı erişimin tasarımda kritik ölçütlerden biri olduğu, iyi ve olumlu sosyal etkileşim sonuçlarının sürekli ürün kullanımı destekleyeceğini görülmüştür. Ayrıca, bireye özel bilgi edinmenin de önemli bir beklenti olduğu görülmüştür. Kullanıcı deneyimlerinin farklı boyutlarının analizi ile gelecekteki kişisel bilişim sistemlerinin tasarımını yönlendirebilecek ölçütler sunulmuştur.

Anahtar Kelimeler: Kullanıcı deneyimi, ikna edici teknolojiler, kişisel bilgi sistemleri, teknoloji aracılığıyla davranış değişimi, kullanıcı ilgisi

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TABLE OF CONTENTS

ABSTRACT v
ÖZ vi
ACKNOWLEDGEMENTS vii
TABLE OF CONTENTS viii
LIST OF FIGURES xi
LIST OF TABLES xiii

CHAPTERS
1.INTRODUCTION 1
1.1. User Experience as Underpinning of Design 2
1.2. Aim of the Thesis 5
1.3. Structure of the Dissertation 5
1.4. Significance of the thesıs 6
2.PERSUASIVENESS OF TECHNOLOGY 7
2.1. Key Developments in Smart Technologies 8
2.2. Attitudes, Motivations, Behavior and Behavior Change 9
2.3. Persuasive Role of Technology 11
2.3.1. Technology as Motivative Tool: Definitions and Dynamics 11
2.3.2. Dynamics and tools of designing for persuasion 14
2.3.3. Research through Design of Persuasive Tools 15
2.4. Personal Informatics Systems as Persuasive Tools 15
2.4.1. Mobile Phone Based Systems 16
2.4.2. Web Connected Systems 18
2.4.3. Product Based Systems 19
2.5. Understanding Users 21
3. USER EXPERIENCE 23
3.1. Definitions and Dimensions of Experience 23
3.1.1. Product-Centered Experience 24
3.1.2. Interaction-Centered Experience 26
3.1.3. User-Centered Experience 27
3.1.4. Understanding Experience from Holistic Perspective 29
3.2. Experience and acceptance of Technological Products 31
3.2.1. Technology Acceptance 32
3.3. User Engagement and Engaging experience 33
3.4. Temporality of experience 34
3.4.1. Measuring Longitudinal User Experience 35
3.5. Experience of Personal Informatics Systems 36
4. METHODOLOGY 39
4.1. Questions to be Answered 39
4.2. First Study 41
4.2.1. Product Selectıon 41
4.2.2. Study Design 43
4.2.3. Measurement Tools 44
4.2.4. Selection of Participants 46
4.2.5. Venue and Equipment 46
4.2.6. Setting- About Ankara 46
4.3. Second Study 46
4.3.1. Product Selection 47
4.3.2. Study Design 50
4.3.3. Measurement Tools 53
4.3.4. Selection of Participants 53
4.3.5. Venue and Equipment 54
4.3.6. Setting – About Pittsburgh 54

4.3.7. Compensation and Costs 54
4.4. Data Analysis Procedure 54
4.4.1. Qualitative Analysis 54
4.4.2. Quantitative Analysis 56
5. EXPLORATION OF EXPECTED CHARACTERISTICS OF PERSONAL INFORMATICS SYSTEMS 59
5.1. Question1: What are the Characteristics and Qualities of Personal Informatics Systems Required for Creating Awareness? 59
5.1.1. Explanation of System Qualities 59
5.1.2. Evaluation of System Qualities 66
5.2.1. Overall Evaluation 70
5.2. Question2: What are the Human-Centered Results of Using the System? 71
5.2.1. First and Final Impressions 71
5.2.2. Stages of Change 72
5.3. Question3: How can people be Motivated to Sustain Usage of Personal Informatics Systems? 73
5.3.1. Sustained Motivation 73
5.3.2. Sustained Usage 74
5.4. Discussions 76
5.4.1. Relations Between Product Qualities 76
5.4.2. Early Experience of Personal Informatics Systems 77
5.4.3. Motivating People to be Active and Sustain theır Usage 80
5.5. Conclusion 80
6. EXPLORATION OF USER ENGAGEMENT IN PERSONAL INFORMATICS SYSTEMS 83
6.1. Question 1: What is the Role of System Qualities in User Engagement? 83
6.1.1. Product Centered Factors 85
6.2. Question2: What are the Human-Centered Results of Using the System in Long Term? 92
6.2.1. Human Centered Factors 92
6.2.2. Initial Goals of Participants to Use The System 97
6.2.3. Results of Stages of Change 98
6.3. Question 3: How do people's Evaluation of the system Change in Long Term Usage? 99
6.3.1. Results of the daily reports and final evaluations 99
6.3.2. Product Centered Questions 99
6.3.3. Human Centered Questions 101
6.3.4. User Engagement: Is/ Is not engaging in terms of experience 102
6.4. Discussions 103
6.4.1. Role of System Qualities in User Engagement 103
6.4.2. Human-Centered Results in Long Term usage 104
6.4.3. Evaluation of the System Change in Long Term Usage 104
6.4.4. Engaging Experience as Inspirational of Sustained Usage 104
7. CONCLUSIONS 109
7.1. Contributions of the Thesis 109
7.2. Research Questions 110
7.3. Comparison of the studies 113
7.4. Design Implications 113
7.4.1. Information Related Implications 114
7.4.2. Product Related Implications 119
7.5. Limitations of the Study 123
7.6. Suggestions for Further Studies 123
REFERENCES 125
APPENDICES
A: Overview of Reviewed Literature-Main Arguments and Related Theories 135
B:Physical Activity Stages of Change 143
C:Non-verbal Pictorial Scale 145
D:Smart Wearable Product Qualities Scale 147
E:Products and System Screened before Selection 155
F:Recruitment text of Study2 163
G:Questions for Study 2 165
Questions for Study 2- Stage1 165

Questions for Study 2- Stage2 167
Questions for Study 2- Stage3 167
Questions for Study 2- Stage4 168
Questions for Study 2- Stage5 (Questions asked to BM09) 170
H:Data Analysis Details of Study1 174
I:Results of Smart Wearable Product Qualities Scale 179
J:Data Analysis Details of Study2.....181
K:Curriculum Vitae.....193

LIST OF FIGURES

FIGURES

Figure 1. Summary of Relations in Literature 2
Figure 2. Relevance and Relation of This Dissertation 4
Figure 3.Persuasiveness of Technology 7
Figure 4. Relations of Psychology Theories 12
Figure 5. Houston system and UbiFit Garden systems (Retrieved from Consolvo et al, 2008, 2009) . 17
Figure 6. Wellness Dairy Screenshot (Retrieved from Ahtinen et al, 2008) 18
Figure 7. Sports Tracker Interface (Retrieved from Ahtinen et al., 2008) 18
Figure 8. Snapshot of IMPACT (Retrieved from Li, 2009) 19
Figure 9. Fish'n Steps (Retrieved from Lin et al., 2006) 20
Figure 10. Snapshot of Breakaway (Retrieved from Jafarinaimi et al, 2005) 20
Figure 11. Snapshot of Philips Activity Monitoring Device (Retrieved from Lacroix et al, 2009) 20
Figure 12. Body Media- Sense Wear Armband (Retrieved from www.bodymedia.com) 21
Figure 13. Visualization of ISO definition of UX 23
Figure 14. Approaches in UX Literature (Reproduced from Forlizzi and Batterbee,2004) 24
Figure 15. Main Components of Product Centered Experience 25
Figure 16. Main Components of Interaction Centered Experience 27
Figure 17. Main Components of User Centered Experience 29
Figure 18. Holistic Approach for User Experience 30
Figure 19. Flow Experience (Reproduced from Csikszentmihalyi, 1990) 34
Figure 20. Model of Experience over Time (Karapanos et al., 2009) 35
Figure 21. Overview of the Methodology 40
Figure 22. Three Models of Body Media Fit 43
Figure 23. Flow of the Study1 45
Figure 24. Body Media System 48
Figure 25. FitBit System 49
Figure 26. Daily Burn System 49
Figure 27. Flow of Study2 52
Figure 28. Data Analysis Methods Utilized to Answer Questions 57
Figure 29. Overview of Study 1: Questions and Major Findings 60
Figure 30. Hierarchy of System Qualities in reference to Mention Percentages 62
Figure 31. Importance-Satisfaction Graph of Product Characteristics 68
Figure 32. Importance-Satisfaction Graph of System Characteristics 70
Figure 33. Satisfaction-Importance Graph of All Qualities 71
Figure 34. First and Final Impressions of Participants 72
Figure 35. Qualities Related to Motivation 74
Figure 36. Qualities Related to Sustained Usage 75
Figure 37. Relations Between Product Qualities in Early Experience 77
Figure 38. Model of Expected Qualities of Personal Informatics Systems 79
Figure 39. Overview of Study 2: Questions and Major Findings 84
Figure 40. Hierarchy of Product Centered Factors in reference to Mention Percentages 89
Figure 41. Hierarchy of Human Centered Factors in reference to Mention Percentages 94
Figure 42. Evaluation of Product Centered Questions 100
Figure 43. Evaluation of Human Centered Questions 101
Figure 44. Flow of Participant Engagement of Personal Informatics System 106
Figure 45. Dynamics of a Personal Informatics System Usage- I 111
Figure 46. Dynamics of a Personal Informatics System Usage -II 112
Figure 47. Design Requirements 114
Figure 48. Overview of Interactivity 115
Figure 49. Overview of Understandability 116
Figure 50. Overview of Connectivity 116
Figure 51. Overview of Personalization 117
Figure 52. Information Related Implications 118
Figure 53. Overview of Appropriateness 119
Figure 54. Overview of Invisibility 120

Figure 55. Overview of Flexibility.....120
Figure 56. Overview of Expressiveness.....121
Figure 57. Product Related Implications.....122

LIST OF TABLES

TABLES

Table 1. Structure of the thesis 6
Table 2. Technological Developments and their Contributions to Smart Technologies 8
Table 3. Similarities between the core theories and persuasive technology literature 11
Table 4. Types of Activity Tracking Tools 16
Table 5. Details of Available Holistic Personal Informatics Systems (May 2011) 42
Table 6. Stages of the Study and Outcomes 43
Table 7. Distribution of Ages in the First Study 46
Table 8. Selected Systems and System Properties 47
Table 9. Stages of the Study and Outcomes 51
Table 10. Survey Questions 53
Table 11. Distribution of Ages 54
Table 12. Example of Coding 55
Table 13. Hierarchy of System Qualities in Reference to Mention Percentages 61
Table 14. Changes in Stages of Activities in Detail 73
Table 15. Hierarchy of Product Centered Factors in reference to Mention Percentages 86
Table 16. Other Product Centered Factors 91
Table 17. Hierarchy of Human Centered Factors in reference to Mention Frequencies 92
Table 18. Other Human Centered Factors 96
Table 19. Participants' willingness levels to use the system at the end of the study 97
Table 20. Initial goals of participants and role of the system in achieving these goals 98
Table 21. Distribution of Initial Physical Activity Stages 98
Table 22. Changes in Stages of Activities in Detail 99
Table 23. One Way Anova Results of Survey Questions 102
Table 24. Literature Review of Psychology Literature 136
Table 25. Product Reviewed 155
Table 26. Data Analysis Details of Study1 175
Table 27. Product Related Results of Smart Wearable Product Qualities Scale 179
Table 28.System Related Results of Smart Wearable Product Qualities Scale 180
Table 29.Means values of system Qualities 180
Table 30. Product Centered Factors (Continued) 182
Table 31. Human Centered Factors (Continued) 187
Table 32. Anova Results of Survey Questions 190
Table 33. Correlations of Survey Questions 191

CHAPTER 1

INTRODUCTION

"Our true mentor in life is science."
Mustafa Kemal Atatürk

Being active plays an important role in overall health and wellness. Lack of physical activity can create common health problems by increasing the risk of diseases such as diabetes, chronic heart disease and obesity. In relation, persuading people to be active has become one of the focuses of developments of technology, aiming towards increasing physical well-being and personal health care.

Recent years, number of research on technology to encourage people to change behavior positively has increased and personal informatics systems has been emerged to serve as tools for changing physical activity behaviors. With advances in sensing and device development, these systems have emerged as mutual concern of design and technology professionals.

Today, technology can assist people by collecting and analyzing data, giving feedback, and supporting them with guidance in achieving the target behavior. Using technology, people are now able to realize how active they are during a day. With this potential, motivating people to be active in the support of the healthy behaviors has been a new focus of Human Computer Interaction (HCI), for especially investigating the potentials of new technologies for encouraging people to exercise and have active lives. Personal informatics systems have appeared in recent years, through which people can track and reflect on personal and contextual data (Li, 2009), and smart devices are able to help people to be aware of their own activities.

Personal informatics systems hold the potential to be a part of people's lives extensively, for those who wish to change or improve the quality of their well-being. These systems create unique experiences as much as every new technology creates. The way these systems track user activities, give feedback and try to motivate them to keep or improve activity behaviors are all important for creating awareness and changing behavior. Therefore, a deep understanding of human behavior and how people engage with these technologies, together with the overall user experience is critical for design of effective personal informatics systems.

As its nature, designing personal informatics systems is multidimensional. As can be followed from Figure 1, it covers understanding the role of technology and psychology of people at the very beginning.

Role of Technology: Developments in technology provided several possibilities for people. Smart environments, context aware systems and smart products can communicate with each other and can sense location and time of an action or identity and activity of the user. Using these infrastructures, smart products that people use have become mobile and more personal. With these advances, technology can be utilized by enriching capabilities of tools; social relations and experience of people. In relation, smart systems have the potential to persuade people, when activated at the right time and right place. This can be done through increasing "users' capacity, creating social relations or creating good experiences" (Fogg, 2002).

Human Behavior: Developing effective persuasive technologies can be achieved by understanding human behavior. At this point, knowledge from the discipline of psychology provides knowledge to understand triggers of behavior and how people can be motivated through technology. In psychology, several theories explain the triggers and deterrents of behaviors. According to attitude-focused theories, such as Elaboration Likelihood Theory, (Petty & Cacioppo, 1986; Petty, Haugtvedt, &

Smith, 1995) people change their attitudes rather than behavior, when there is an imbalance between people's feelings and behaviors. On the other hand, behavior-focused theories, such as Theory of Planned Behavior (Ajzen, 1991, 2005; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 2005), define attitudes and motivations as strong determinants of performing a behavior. For instance, Social Cognitive Theory defines "motivational process" in which people affect their behaviors by self-evaluation of outcome behaviors. In relation, Theory of Reasoned Action defines motivation as a prominent factor of behaviors (Fishbein & Ajzen, 2005).

Motivations influence the way people tend to perform a behavior (Bandura, 2001). They are the indicators of "…*how hard people are willing to try and how much of an effort they are planning to exert, in order to perform the behavior* (Fogg, 2002, pg.181)". When the person is motivated, the possibility of performing behavior increases. The behaviors are more likely to change when people have motivation and they tend to appreciate the outcome of the behavior. When the outcome of the behavior is believed to be valuable, then the behavior is more likely to subject to change. Still, there are other factors, that both affect the beliefs and motivations of people. These factors can be internal factors like the abilities and emotions of the person or external factors like opportunities and the level of dependence on other people of the intended behavior (Ajzen, 1991). All these also affect the way a persuasive technology can be a "trigger of behavior change".

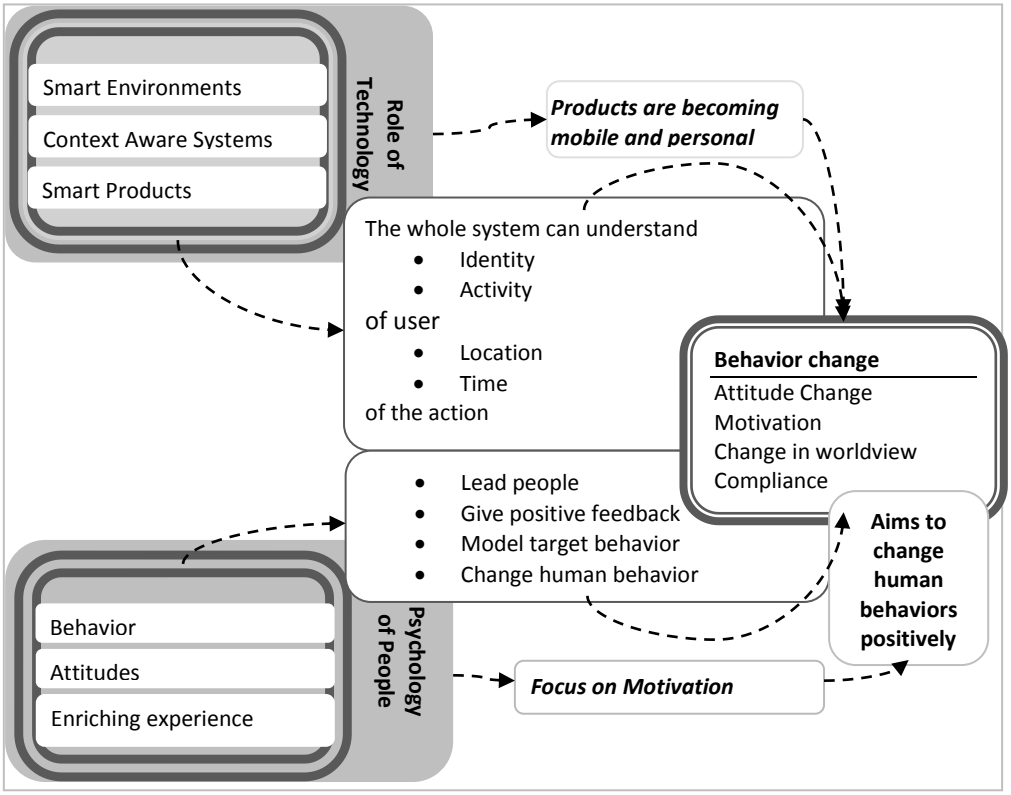

Figure 1. Summary of Relations in Literature

1.1. USER EXPERIENCE AS UNDERPINNING OF DESIGN

With the aforementioned understandings, design can serve as the connector between people and technology. To achieve this, from the designers' side, it also requires understanding of user.

Each technological development creates new and unique experience. Personal activity tracking is a new type of experience as these products give "personal" information about its users. Designing these systems requires exploration of user needs and reactions towards the technology. Hence, it requires understanding of how people experience the technology and what their real needs are. In relation, user centered methods can be utilized for understanding the way people wish to use and interact with these

systems. It is recently argued that experience of and interaction with certain products or systems is different each time. The experience of personal informatics systems can even be different as this type of technology offers more intimate interactions, and the products might be more personal than any other personal products.

As illustrated in Figure 2, the major exploration of this dissertation is "user experience of personal informatics systems". In achieving this, the scope of this dissertation covers behavior and motivations, user experience and persuasive technologies.

Designing novel smart technologies requires realization of user needs, as lack of this information will lead to misunderstanding of user expectations. The way the user interacts with the personal informatics systems and the way these systems give feedback to people have been explored by HCI researchers to figure out and improve the interaction between technology and people. However, experiencing these systems is new and different. These systems have unique characteristics, such as giving feedback about its user, and they create challenges for designers to design effective systems. Thus, understanding user experience holistically is critical for design of effective personal informatics systems.

One important point in *experience* is that it is subjective, private and personal. Experience of each person is different from one another, as abilities, motivations and expectations of each person can be different. It is also clear that characteristics of every technology affect the way people experience the technology. While a specific technology can cause positive experience for one person, it can cause negative results for another. There are several frameworks in UX literature focusing on experience of users with systems, products or specific kind technologies. Refining and redesigning these frameworks is required to help the designers to get the most benefit from the HCI and design literature.

The characteristics of personal informatics systems, (i.e., being mobile, smart and personal,) have already entered people's lives in the form of smart phones which empowered the mobility of information. Still, the idea of being "personal" requires corroboration with advances in *persuasive technology*. Focusing on developments and personal technologies, understanding the current state in persuasive technology will contribute to the possibilities of future systems in changing behavior. On the other hand, understanding change in behavior and emergence of motivation and behavior change become vital for designing these systems. *Theories of behavior* are essential guides in understanding attitudes, motivations and behavior of people in that sense. At the time of this dissertation, no coherent framework is available for designers to understand user experience of personal informatics systems.

It is known that, when the novelty effect of these systems pass, the level of motivation to keep using the product depends on have these tools can respond to changing user needs (Li, 2011). Keeping people engaged with the system will ensure long term efficiency of these systems. Research continues to grow in academia, as there is great potential in building new systems in relation to changing user needs. In addition, it is up to designers to make these tools relevant to what people expect from these tools. Therefore, it is important to frame the dimensions of user experience and engagement particularly for these tools.

Understanding user experience of these systems requires hands on experience of users. To do this, this thesis covers two user studies. First study explored the dimensions of user experience in short term usage which also defined the user needs and expectations. With the findings of the first study, a second study was needed to understand user engagement in long term usage. Outcomes of these two studies help to put forward the user requirements of personal informatics systems to design for user experience.

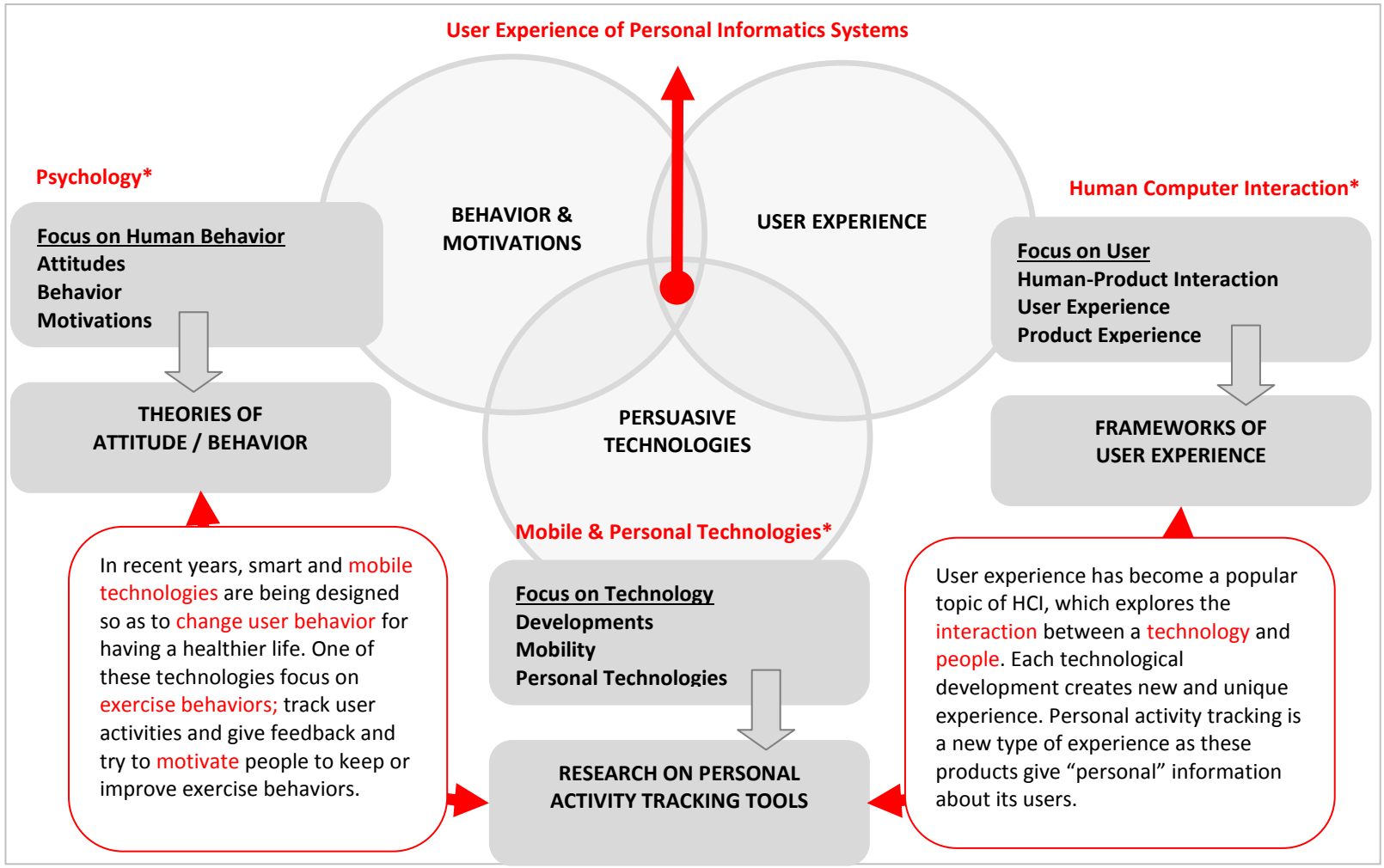

Figure 2. Relevance and Relation of This Dissertation

1.2. AIM OF THE THESIS

The scope of this dissertation was to explore the dimensions of user experience of personal informatics systems, and put forward a model of relations for people to engage with these systems. In order to accomplish this aim, there were mainly three investigations that will go hand in hand, that constitute the structure of the model: *(i)* understanding user behavior, attitudes and motivations, *(ii)* exploring the physical and technological properties of current personal informatics systems as persuasive technologies and *(iii)* understanding the dimensions of user experience.

These investigations were done by answering the research questions below:

(i) Understanding user behavior, attitude and motivations

- What is the relation between human behavior, attitude and motivations?
- What are the triggers of human behavior?
- How do motivations affect human behavior?

(ii) Exploring the personal informatics systems

- How does the technology evolve to make people aware of themselves?
- How can human behavior be changed through technology?
- How can the personal informatics systems change human behavior?

(iii) Understanding the dimensions of user experience of personal informatics tools

- How do people experience interactive products? What are the dimensions of user experience?
- How do people's experience and engagement evolve over time?
- What are the dimensions of early experience of personal informatics systems?
- What are the dimensions of user engagement to sustain usage of these systems?

To answer the listed questions and to create a model;

- Literature of psychology was explored to understand the human behavior and the triggers of changing behavior.
- Investigation of relations between psychology and persuasive technologies were examined with an aim to understand how technology can contribute to changing behavior positively.
- HCI literature was reviewed to define the dimensions of user experience and user engagement.
- Details of two user studies were explained, to determine the dimensions of user experience and engagement of personal informatics systems. These studies contribute to reach a holistic model of user engagement of personal informatics systems.

1.3. STRUCTURE OF THE DISSERTATION

This dissertation consists of seven chapters and three parts (Table 1). Chapter 2 and 3 form the exploratory stage. Chapter 4, 5 and 6 explain the details of user studies conducted to explore the dimensions of user experience and engagement. Final chapter covers the conclusions and contributions of this dissertation.

Chapter 2 will explore the term "persuasive" through turning to persuasive technology and psychology literatures. This chapter will also explain recent studies of personal informatics systems and conclude with putting forward the challenges of designing persuasive personal informatics systems. Chapter 3 will be the second exploratory chapter, in which the HCI literature will be explored to understand the dimensions of user experience and engagement.

With the relations of literature, Chapter 4 present the methodology of the field studies; Chapter 5 and 6 present these studies which explore the dimensions of user experience and engagement of personal informatics systems. In chapter 7, discussions of the proposed model and contributions of the models presented will be stated.

Table 1. Structure of the thesis

Exploration	*Chapter Content*	*Questions to be answered*	*Number*
Exploration of Literature	Persuasive Technologies	*How does the technology evolve to make people aware of themselves? *How can human behavior be changed through technology?	Chapter 2
	Personal informatics tools as persuasive technologies	*How can the personal informatics systems change human behavior?	Chapter 2
	Psychology of human behavior	*What is the relation between human behavior, attitude and motivations? *What are the triggers of human behavior? *How do motivations affect human behavior?	Chapter 2
	User experience	*How do people experience interactive products? What are the dimensions of user experience? *How do people's experience and engagement evolve over time?	Chapter 3
	User engagement		Chapter 3
Exploration of early user experience and user engagement	Methodology of Field Studies		Chapter 4
	Field study 1 : Understanding the characteristics and qualities that would lead to awareness and motivation during the early days of usage	*What are the dimensions of early experience of personal informatics systems?	Chapter 5
	Field study 2 : Understanding user needs and expectations in long term usage for user engagement	*What are the dimensions of user engagement to sustain usage of these systems?	Chapter 6
Contributions	Discussion of the framework Conclusions		Chapter 7

1.4. SIGNIFICANCE OF THE THESIS

This thesis is important for the literature in terms of two reasons. First, it is important as it provides a comprehensive knowledge for designers in understanding the key aspects and evolution of *user experience of persuasive technology*. Designers can regard to this thesis as a reference that can be applied during the design process of personal-persuasive technology. Second, this thesis provides the dimensions of user engagement specialized for personal informatics systems. It explores the key qualities that play role in engagement and disengagement of those kinds of systems in long term usage. These can also be applied by designers of personal products and system that aim to change people's behavior. Besides, the implications suggested in Chapter 7 can be regarded as knowledge that will guide design process of similar systems.

CHAPTER 2

PERSUASIVENESS OF TECHNOLOGY

Developments in technologies contribute to the success of smart devices and systems. Utilizing the wireless networks, they offer new and versatile interactions (Abowd & Mynatt, 2000; Chong et al., 2010). These technologies have sensors, memory and networking capabilities through which they know "itself (its functions), actual environments and its users" and act accordingly (Mühlhäuser, 2008). In addition, the improvements in smart technologies, at both environmental and hardware systems, empowered the mobility of users, by making information to be reached from everywhere (Becta, 2007; Dvorak, 2008; Poslad, 2009).

In the last decade, using smart products and applications to persuade people for either creating awareness or changing behavior positively has become a popular topic within design and technology researchers (Fogg, 2002; Lockton, Harrison, & Stanton, 2008). Even though the term "persuasive technology" is widely used, it is obvious that, since technology emerged into people's lives, it is constantly influencing people's behavior.

The human behavior and technology are always interrelated; people's behavior affect the way the technology is used and the abilities of the technology affect the ways people behave (Slob & Verbeek, 2006). However, this mutual effect can be considered as "unconscious", as the technology developers do not *intend to* change people's behavior, but the change comes spontaneously. On the other hand, persuasiveness of technology is different from an unconscious influence of technology (Figure 3). Persuasive technology is purposefully *designed* to develop or improve a desired behavior. That is, persuasive technology aims at the activities that result in a "*desirable output for the environment and the user*" (Arnold & Mettau, 2006; pg.13). In addition, persuasion is about a "voluntary change in attitude or behavior" (Fogg, 2002). Therefore, technology has loaded new and conscious role: *persuasion.*

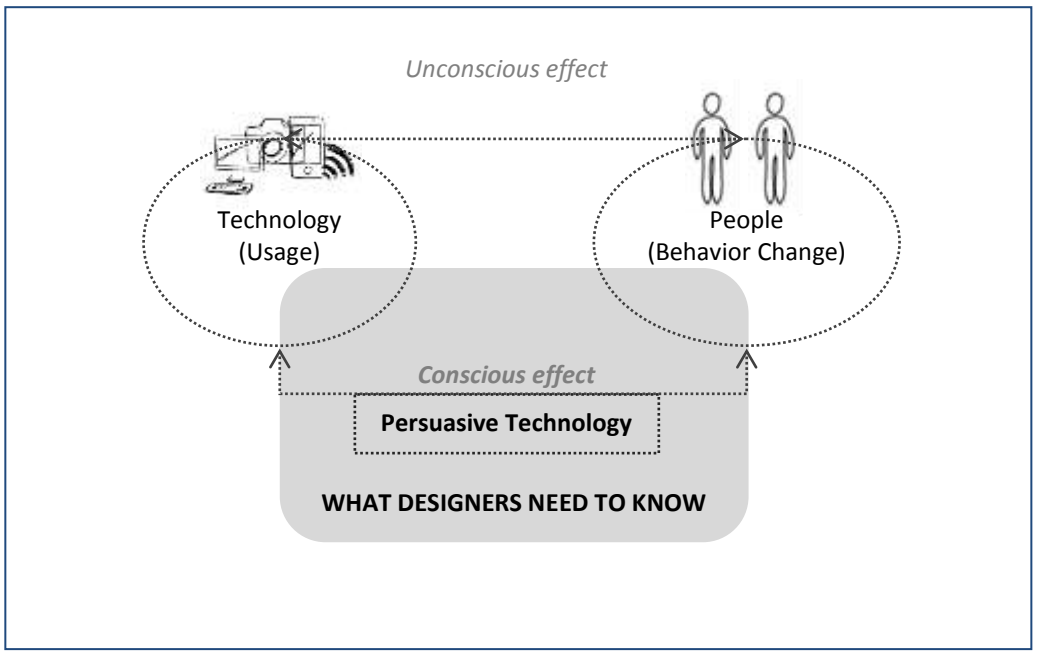

Figure 3.Persuasiveness of Technology

It should be remembered that, throughout this thesis, the term "smart technology" will be used for all kinds of infrastructures and devices that have sensors and actuators. These technologies can sense, interpret and give feedback related to people's activities and actions. "Smart products and devices" are the physical forms of smart technologies which have sensors inside, sense people's actions through these sensors, process this information, and act and give feedback accordingly.

2.1. KEY DEVELOPMENTS IN SMART TECHNOLOGIES

The infrastructures play a prominent role in the experience of smart technologies as the abilities of infrastructures can both support or restrict the interactions. One of these infrastructures is ubiquitous computing systems which create grounds for smart technologies. Wireless infrastructures for supporting mobile computation have been constructed over the years, and ubiquitous computing systems have started to put novel interactions forth, by facilitating information to be easily accessed from everywhere (Abowd & Mynatt, 2000; Chong et al., 2010). The core properties of ubiquitous computing is defined as "interaction fluency, interaction transparency and context awareness" (Poslad, 2009). By sensing user's location through invisible systems, understanding user's identity, user's activity and the usage time (Dey & Abowd, 1999), smart technologies support the mobility of users by making information possible to be reached at all times (Becta, 2007; Dvorak, 2008). Today, people use ubiquitous computing systems, such as wireless connections, RFID tags and GPS applications in daily life. Most of the new and personal technological products, such as smart phones and tablet pc's, serve as the tools of ubiquitous computing systems. For instance, through wide variety of applications, smart phones have been converted to be a means to get connected to the world. These developments make it evident that smart technologies have already been infused into people's lives.

Table 2. Technological Developments and their Contributions to Smart Technologies

Technological Development	***Development Outcomes***	***Improvement of Quality***
Ubiquitous Computing	*Availability of information and communication in anywhere-anytime *(Weiser, 1993)* *Mobility of user data *(Becta, 2007)*	Empower networking systems *(Starner, 2001)* Support mobility *(Moen, 2007)* Enable localized information *(Rhodes, Minar, & Weaver, 1999)*
Context Awareness	*Sensibility of the users' location, emotional state and environment *(Brown, Bovey, & Chen, 1997; Ryan, Pascoe, & Morse, 1997)* *Adoptability to the sensed context *(Baldauf, Dustdar, & Rosenberg, 2007)*	Sense where, in which condition the user is *(Amft & Lukowicz, 2009)* Act according to the sensed situations *(Amft & Lukowicz, 2009)* Enable more effective usage *(Dvorak, 2008)* Empower the mobility of the user *(Abowd, Dey, Orr, & Brotherton, 1998)*
Miniaturization	* Manufacturability of smaller-sized and higher-speed versions of devices and system boards with all needed functions *(Tummala & Swaminathan, 2008)*	Enable production of small and light-weight products *(Bass et al., 1997; Klein & Toney, 2000; Roy & Agrawal, 2003)* Enable portability of the all the personal products *(Constas & Papadopoulos, 2001)*

By gathering contextual data, such as location, time, identity and activity context-aware systems increase usability and effectiveness of the applications by reacting according to the changing contexts

immediately (Baldauf et al., 2007). Some researchers define context as the "location and environment of the user", such as the user's state and environment including time and location (Brown et al., 1997; Ryan et al., 1997) as well as the emotional state of the user (Dey, 1998), and some define the context as the "environment of the applications and objects" (Brown, 1996; Hull, Neaves, & Bedford-Roberts, 1997; Rodden, Cheverst, Davies, & Dix, 1998). In all conditions, the context includes *location, identity, activity and the time* of either the user or the application (Dey & Abowd, 1999). As the technology flourishes, through the context-aware applications and ubiquitous computing, more and more computing devices set the users free from stationary computers to mobile products (Abowd et al., 1998; Chen & Kotz, 2000).

Miniaturization of electronic parts also plays an important role in development of smart products. With miniaturization, electronic devices have become smaller and smarter with embedded sensors (Edwards, 2003). In relation, miniaturization, enables production of small and light-weight products (Bass et al., 1997; Klein & Toney, 2000; Roy & Agrawal, 2003). While becoming smaller in size, products became faster in performance (Tummala & Swaminathan, 2008). With all these, each technological development contributed to the improvements in qualities of smart products (Table 2). Advances in ubiquitous computing empowered the networking systems (Starner, 2001) by enabling localized information to be reached in all conditions (Rhodes et al., 1999). Context awareness contributes to sensing where and in which condition the user act according to the sensed situations (Amft & Lukowicz, 2009) by enabling more effective usage (Dvorak, 2008). All these developments enable portability of the all the personal products (Constas & Papadopoulos, 2001) by empowering the mobility of the user (Abowd et al., 1998; Moen, 2007).

Today people carry sensors and actuators, such as small cameras, microphones, text editors and GPS, by only carrying light-weight personal products. Smart phones, for instance, having all these sensors, are able to instantly track everything people do and enable people to tell about their activities to the rest of the world. The applications, designed for tracking and sharing data, like Foursquare for checking-in where the user is or like Instagram for sharing the pictures of events and environments people are in, have become popular communication tools of social media. Even though, the idea of capturing where people are and what they are doing sounded bizarre when the early applications were relieved, today people track and share this information willingly (Ludford, Priedhorsky, Reily, & Terveen, 2007).

Research in HCI about smart technologies made these technologies become important contributors of new experiences, for i.e., entertainment, health care, sports and communication. One of these researches is in motion sensing technologies, which led to advances in smart entertainment products. Recently, Sony relived the "Play Station Move" bundle, (Sony, 2012), which has a motion sensing camera and a hand-held motion controller, through which movements of people are captured. Microsoft X-Box+Kinect console, for instance, has motion sensors inside. Through these sensors, the device can catch the motions of the players through a camera, transmit them to the video console, and create a fun experience for its users, needless of extra device on body (XBox, 2012). These examples make it clear that smart technologies are able to sense actions and movements of people through small sensors, offering researchers the potentials in developing personal informatics tools.

With the technological developments, health care and personal well-being have become one of the main concerns of interdisciplinary research. Discovering the abilities of ubiquitous computing, technology is now able to help people to change behavior (Fogg, 2002). As a result, the persuasiveness of technology has emerged as a new research area in the last decade. Persuasive technology is challenging for researchers as it is still open to user research (Consolvo, McDonald, & Landay, 2009). Still, understanding the effect of persuasive technology requires understanding of human behavior and behavior change first. Utilizing psychology literature is an important step, to explore the underlying reasons of human behavior and determinants of behavior change from psychological perspective through which how the technology can serve as a tool for motivator of behavior will be interpreted.

2.2. ATTITUDES, MOTIVATIONS, BEHAVIOR AND BEHAVIOR CHANGE

In the comprehensive book of Petty and Cacioppo (1996), attitudes are defined as "a general and enduring positive and negative feelings about some person, object or issue" (pg.7). In other words, attitudes are *feelings and thoughts* about an attitude object (Fiske, 2004). Whereas, behaviors are the

actions and movements of people towards internal and external events (Sarafino, 1996; Sundel & Sundel, 2005). It involves a process of evaluation of cognitions and an act according to the cognitions.

To comprehend the relations between attitude, motivation and behavior, fifteen theories regarding attitudes and behaviors have been reviewed, starting from the theories of attitudes. The ones that are "historically" connected are presented in Figure 4. The main purpose of this review was to understand the key issues of attitude and behavior rather than figuring the holistic picture of psychology literature. Besides, for a designer, it is irrelevant and impossible to understand and explain all the theories of behavior. Thus, the review process ended when a certain understanding of behavior was reached.

The review shows that there is a close relationship between attitude and behavior. Some of these theories are the core theories that others are deprived of (Benoit & Benoit, 2008; Petty & Cacioppo, 1996). For instance, the Balance Theory (Heider, 1944, 1958) can be regarded as the core theory of Congruity Theory (Osgood, Suci, & Tannenbaum, 1957; Osgood & Tannenbaum, 1955) and Cognitive Dissonance Theory (Festinger, 1957). The review of the theories starts with the attitude related theories, since attitudes can be a determinant of behavior (Ajzen, 1991, 2005). At the end, behavior and behavior change theories are investigated. These theories are summarized in Appendix A and the main arguments and the relations between these theories are presented in Figure 4.

The main difference in theories is the status of behaviors within the theories. In very basic terms, Theory of Reasoned Action (Fishbein & Ajzen, 2005) state that, *attitude is predictor* of behavior; while in Self Perception Theory (Bem, 1972) the *behaviors are predictors* of other behaviors. This contradiction can be best overcome by thinking attitudes and behaviors simultaneously and motivations as the key for the purpose of changing a behavior. An overview of the literature on related theories can be found in Appendix A.

Psychology literature reports two approaches explaining the relations between behaviors and attitudes. In the first approach, behaviors are defined as the determinants of attitudes. For example, for Self Perception Theory (Bem, 1967), people think about the past behaviors and infer internal states, namely attitudes and can also make same conclusions about the attitudes by observing the others behaviors and environmental constraints. The second approach describes the relation more complicated than the attitude based theories. The attitudes and self-beliefs are defined as the predictors of the behavior; however, these are not the only predictors. As an example, Ajzen and Fishbein (1980) define 3 predictors of behavior change in Theory of Reasoned Action (TRA) and attitude towards the behavior is one of the determinants of behavior together with subjective norms and perceived behavioral control.

The psychology literature also asserts causal relations between changing attitudes or behaviors. Theories, such as Cognitive Dissonance Theory (Festinger, 1957) and Social Judgment/Involvement Theory (M. Sherif & Hovland, 1961) state that attitudes are easier to change than behaviors. Therefore when people have attitudes that do not overlap with their behaviors; they generally choose to change attitude, rather than the behavior. On the other hand, theories exploring the reasons of behaviors such as Theory of Reasoned action and Social Cognitive Theory, define self-beliefs and attitudes as the predictors of the behavior. It is stated that, when people have attitudes towards behaviors, the behavior is likely to change.

Motivations have also a vital role in changing both attitudes and behaviors. Motivation and processing ability of the person is a determinant of attitude change: without these, a message cannot persuade a person to change the attitude (Petty & Cacioppo, 1986). Motivation is also an indispensable factor of behavior change. Social Cognitive Theory (Bandura, 1989, 1999, 2001) defines a motivational process in which people affect their behaviors by self-evaluation of outcome behaviors. Theory of Reasoned action (Ajzen & Fishbein, 1980) also defines motivation as a prominent factor of behaviors. When people have motivation and appreciate the outcome of the behavior, the behaviors are more likely to change. In relation to these two theories, behavior change is related to how the person appreciates the goal and what expects from the behavior (Fishbein & Ajzen, 1972). When the outcome of the behavior is believed to be valuable, then the behavior is subjected to change.

Above all, the Transtheoretical Model of Behavior Change (Prochaska & DiClemente, 1983) claims that behaviors are too complicated to be defined and discussed through a single model of behavior. This approach simplifies the complicated relations between the attitudes and behaviors by combining and reviewing the psychology literature on behavior and behavior change. The basis of this model is

health care; however the stages and process of behavior change in this model are universal and can be applied to understand why and how people change behaviors.

According to these interpretations, the current thesis utilizes Transtheoretical Model of Behavior change (Prochaska & DiClemente, 1983), Social Cognitive Theory (Bandura, 1989, 1999, 2001) and Theory of Reasoned Action (Ajzen & Fishbein, 1980), as these theories explain the way people change or resist behaviors in a multidimensional manner. Meanwhile, analysis of Theory of Reasoned Action and Social Cognitive Theory showed that both of these theories has interrelations with what Fogg (2002) explores in persuasive technology.

2.3. PERSUASIVE ROLE OF TECHNOLOGY

According to Fogg, persuasive technologies have three main roles: tools, social actor and medium. In relation, as explained in according to Social Cognitive Theory, "social diffusion of new styles of behavior" (Bandura, 1999) has three functions: *adoption determinants* which includes self-efficacy and are related to personal evaluations; *symbolic meaning* which is mainly related to increasing knowledge and values as an outcome of behavior; and *social networks* which creates social connections between other members of the society. These also have commonalities with the determinants of behavior expressed in Theory of Reasoned Action (Fiske, 2004): *control beliefs* are the ones that make people believe that they can perform the specific behavior; and *behavioral beliefs* are the ones that make people to think about the outcome and results of the behavior and *normative beliefs* are the ones that make people think that performing a specific behavior will lead to social acceptance. The below table (Table 3) contributes to understanding coincidences of the theories. Moreover, it helps to understand how people experience technology, in terms of being a;

- *tool* affecting control beliefs/adoption determinants;
- *medium* affecting behavioral beliefs/symbolic meaning;
- *social actor* affecting normative beliefs/social networks.

Table 3. Similarities between the core theories and persuasive technology literature

Social Cognitive Theory	***Theory of Reasoned Action***	***Persuasive Technologies***	***How Technology can Contribute to Behaviors***
Adoption Determinants	Control Beliefs	Tools→	Increase User Capability
Symbolic Modeling	Behavioral Beliefs	Medium→	Provide Experience
Social Networks	Normative Beliefs	Social Actor→	Provide Social Support

Persuasive technology literature can be explored under three focuses of researchers: technology as motivative tool (definitions and dynamics), dimensions and tools of designing for persuasion and research through design of persuasive tools.

2.3.1. TECHNOLOGY AS MOTIVATIVE TOOL: DEFINITIONS AND DYNAMICS

Human behavior is a complex phenomenon to understand. Thus, changing behavior, especially the habitual behavior (i.e., smoking) through technology requires multidimensional understanding of user-technology interaction. Changing behavior through technology focuses on developing an interactive system or product that helps people to get motivated. Fogg states that (2002), technology can persuade people for affective behavior change by *motivating users, leading them and giving positive feedback* for achieving the target behavior. He argues that, persuasive technologies have three main roles: *serving as tools, social actors and medium.*

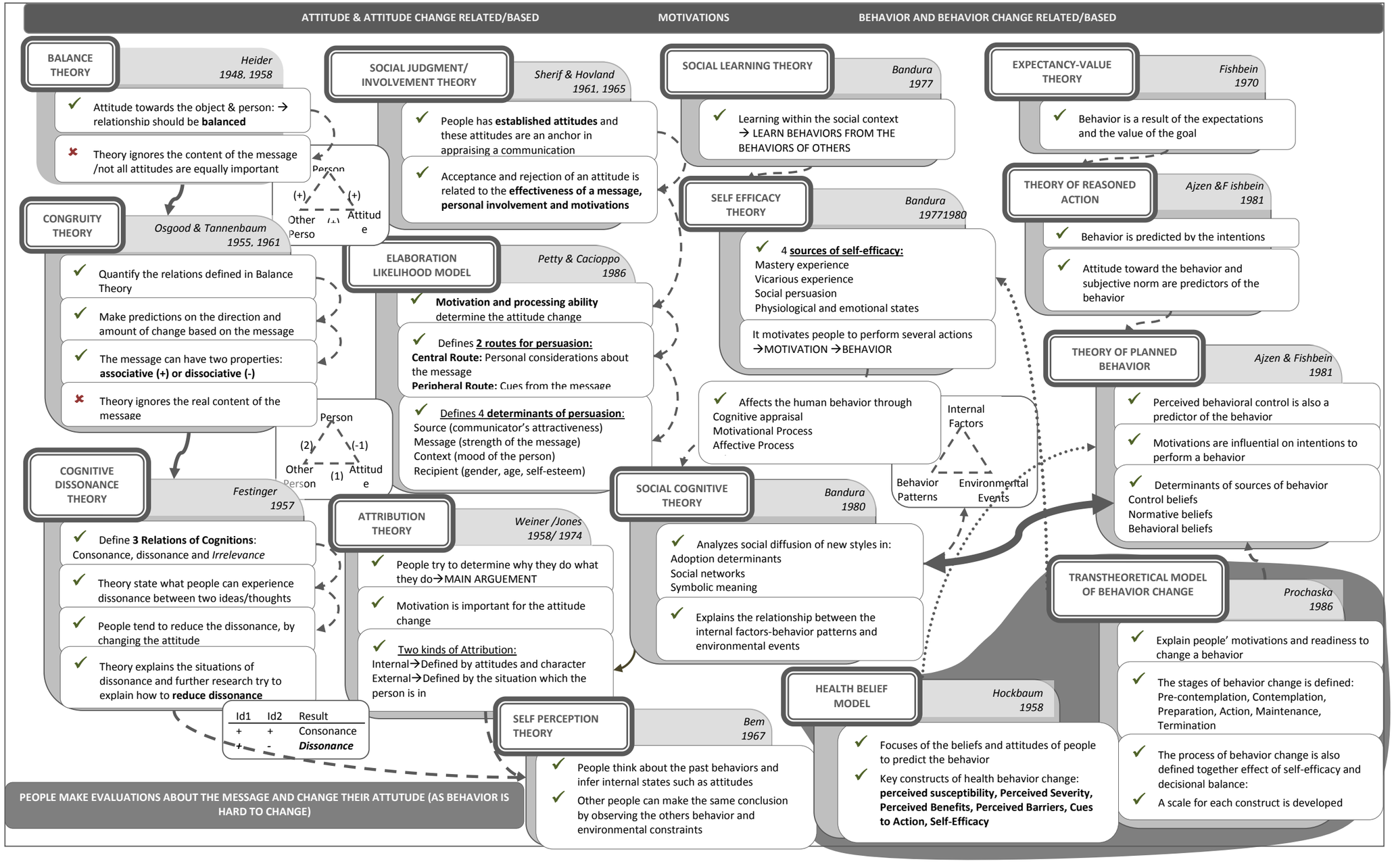

Figure 4. Relations of Psychology Theories

In his book, Fogg (2002) states that persuasive technology serves as *tools* for increasing the human capacity and making targets easy to achieve. It serves as *social actors* by creating relationships with other people, by giving positive feedback as if the technology is like living things. Finally, it serves as *medium* by providing positive experience with providing simulations as if the user is experiencing the application/product in real environments. While exploring these roles, Fogg (2002), in addition to the medium, tool and social role of technology, stresses the importance on context and timing, so as to influence attitudes and behavior. He also states that, using the ubiquitous systems as infrastructures, *"new computing capabilities, most notably networking and mobile technologies, create additional potential for persuading people at the optimal time and place"* (pg 184). In other words, mobile technologies and network systems have the potential to persuade users when enabled at the *right time and right place*.

In relation to Fogg, the information and feedback given by the technology are the important motivators of the people's decisions of performing a behavior. The technology affect people's decisions at three levels: It can *guide the behavior* by giving feedback to inform the user about the outcomes of target behavior; can *steer the behavior* by encouraging the user in a predefined way and can *sustain behavior* by making use of persuasive methods to change the way people think and behave (Lilley, 2009). Still, the control should be on the user; the feedbacks shouldn't be disturbing the users as they will be conscious about what the technology is trying to achieve (Lilley, 2009). In relation, changing behavior through technology includes interventions and preventions (Heijs, 2006a). Thinking that the user could be willing but resistive to change, technology should first weaken the relatives of behavior, and thus make the "necessity of behavior" questionable. After breaking the resistance, *prevention* comes into prominence; technology can make attempts to prevent the previous behavior and encourage the desired behavior (Heijs, 2006a).

From the users' side, the information is required to be processed in which the user interacts with the technology (Heijs, 2006b). The user first processes the information with sensory organs *(sensation)*; then synthesize the information through mental processing *(perception);* recognizes the information as a driver of behavior *(cognition)* and relate the behavior with emotions *(affection)* (Heijs, 2006b).. At the end of this process, user is expected to internalize a new behavior. However, these steps are only the initiator of behavior, and the process can go a back loop, namely rebound effect (i.e, perception does not necessarily lead to cognition) (Midden, 2006). In addition, there can be other constraints that affect the process, such as attitudes, habits and intentions (Heijs, 2006b).

Considering these, it will be important to understand how "people perceive persuasive technology". Decisions of performing a behavior is in people's own will, however, people can be conscious about what the given information aims at (Tromp, Hekkert, & Verbeek, 2011). Accordingly, a product can be *coercive, decisive, seductive or persuasive*, in relation to the level of salience and force (Tromp et al., 2011). Even though authors categorize influence of product, this categorization can also be applied to technology. In relation, a technology can be;

- *Coercive* if the salience is apparent and the force is strong, such as constant audial feedback to warn the driver about the unfastened seatbelt,
- *Decisive* if the salience is hidden and the force is strong, such as visual feedback to the driver about speed limits
- *Seductive* if the salience is hidden but the force is weak, such as the effect television on family communication
- *Persuasive* if the salience is apparent but the force is weak, such as an automatic short message to remind the user about positive effects of physical activity

According to Tromp et al, (2011) even though the effect of the product can be categorized, how it is experienced by the user can differ; a product can be persuasive for a user, but it can be coercive for another user. It depends on how the message of the product (or technology) is perceived. Accordingly, the distinction of being informative or persuasive of a message is shaped by people's experience (Crilly, 2011) .

2.3.2. DYNAMICS AND TOOLS OF DESIGNING FOR PERSUASION

In relation to the aforementioned dynamics, technology can be designed to persuade people to increase their motivation, abilities and trigger a certain behavior (Fogg, 2009b). Thus, a behavior is more likely to change, when the person is highly motivated, when the abilities of the person are increased with the abilities of the technology and when the person is prompted to perform a behavior at certain times (Fogg, 2009b). These reveal new challenges for researchers and technology developers. By putting forward the possibilities of the technology, people can be motivated to perform a behavior.

In addition to these roles, Fogg states 7 types of tools that can be designed for persuading people. These include;

- *Reduction*; in which the tools should reduce the amount of effort that the user will take to perform a behavior
- *Tunneling*; in which the tools should not reinforce users with all types of activities at once, rather the user should be led to an activity in a sequence.
- *Tailoring;* in which the information that the persuasive technology should be "tailored" to the user, providing individual-specific feedback.
- *Suggestion*; in which the persuasive system should offer suggestions to empower the effect of it on behavior.
- *Self-monitoring*; in which the user should be enabled to monitor their own activities so that the barriers to the target behavior can be eliminated.
- *Surveillance;* in which the technology should enable the user to observe the other people's behavior in a certain way to distinguish similar behaviors in others.
- *Conditioning*; in which the technology should reinforce the user to sustain the behavior or turn a behavior into habits.

In relation, designing persuasive systems should ensure positive dialogue between the user and the technology. To do this, persuasive technology should communicate through (Oinas-Kukkonen & Harjumaa, 2008);

- *Praise;* such as sending automatic messages to reach the target behavior
- *Rewards;* such as providing the user with virtual rewards for performing the target behavior
- *Reminders;* such as reminding the user of their target behavior periodically
- *Suggestion ;* such as giving suggestions about the target behavior during use process
- *Similarity;* such as reproducing the user behavior in a meaningful way
- *Liking;* such as making the system and feedback appealing
- *Social role;* such as embracing a social role

There are several strategies that can be followed to design for the desired behavior. One of these is the Behavior Grid of Fogg (2009a). In Behavior Grid, the effect of the technology is related to the *type* of behavior change; whether the behavior is familiar or unfamiliar or whether the goal is to increase, decrease of stop a behavior; and the *schedule* of behavior; whether it is a one time, repeated, periodical or life-long behavior, or whether behavior depends on people's willingness (Fogg, 2009a). Fogg states that, the type (5 cases) and schedule (7 cases) of behavior form 35 types of behavior change, and the designers should first understand which type of behavior change is aimed at.

It is possible to say that, by solving the *problems* related to use cases, designers actually design the use behavior by solving the problems of *actions* in those problems (Houkes & Vermaas, 2006). In this sense, designers need knowledge about both the technology and behavior. (Houkes & Vermaas, 2006). In relation, persuasive design is about both the design of technical parts of products and

systems as well as the issues related to user-centered characteristics of the technology (Redström, 2006); from the perspective of designers, it is important to understand the behavior of *users* of a technology. As a starting point, understanding the *constraints and affordances* for the intended behavior is critical for designers (Lockton et al., 2008); what people can do and what people resist to do. Therefore, it becomes vital to understand the human behavior in detail.

In order to help designers to understand the intended behavior and thereby "design for intent", a twofold toolkit is suggested, which can be utilized depending on the preference of the designers (Lockton, Harrison, & Stanton, 2009, 2010). They are suggested a set of inspirational design patterns to open up the design problem in relation to the purpose of the behavior (inspiration), and applicable design patterns in which the "target behavior" is categorized in relation to already applied patterns. It is also suggested that, after categorizing the target behavior, the design process can be followed by inspiration patterns (Lockton et al., 2010). The aim of this method is to provide general guidance for designers and design teams to influence a certain type of user behavior.

2.3.3. RESEARCH THROUGH DESIGN OF PERSUASIVE TOOLS

There are two main issues that technology researchers seek to motivate people. These focus on environmental and personal health issues. The studies that focus on environmental issues explore ways to create awareness about those issues, and motivate people to use less world resources, such as cutting down the water or energy consumption. Creating environmental awareness is aimed at increasing the well-being and standards of living in the long run. The developed applications mainly focus on, but not limited to, creating sustainable environments (i.e, Froehlich, Findlater, & Landay, 2010) , and energy consumption (i.e., Foster, Lawson, Blythe, & Cairns, 2010) as behavior change in energy and water consumption is needed for *saving the earth*.

On the other hand, the studies that focus on personal health issues are more people oriented: these studies also focus on personal well-being, and those try to provide approaches to healthy life by giving feedback about the users' bodily changes. Those applications focus on, but not limited to, empowering the physical well-being (i.e, Hong, Jeong, Arriaga, & Abowd, 2010) and motivating people to be physically active (i.e.,Berkovsky, Coombe, & Helmer, 2010), as people are getting unhealthy with their eating habits and stationary living environments.

The mutual concern of these issues is that both try to strengthen the persuasive role of technology in people's lives, by taking the advantage of the developments explained in the previous sections. These highlight several challenges and strategies to design for behavior change. In this vein, personal informatics systems are also one of the persuasive technologies which can be considered as the matter of research through design.

2.4. PERSONAL INFORMATICS SYSTEMS AS PERSUASIVE TOOLS

Personal informatics systems are a set of systems that serve as persuasive tools, aiming at helping people to "collect and reflect personal information" (Li, Dey, & Forlizzi, 2010). Mainly, these systems focus on making people aware of themselves, by giving personal information (i.e., their physical activity level) and motivate them have better behavior (i.e, to get active).

Physical activity has positive effects on personal well-being, as it is required to maintain health and reduce illness effects (Consolvo, Everitt, Smith, & Landay, 2006). Basically, physical activity "*results in energy expenditure and has positive correlation with physical fitness*" (Caspersen, Powell, & Christenson, 1985, pg.2), but people relate lack of physical activity to several factors such as *lack of time, energy, motivation and social influenc*e (Sallis & Hovell, 1990). Besides, physical inactivity is stated to be one of the most important problems of 21th century as it leads to cardiovascular diseases and obesity (S.N. Blair, 2009). Therefore, focusing on physical activity is a promising research area for persuasive technology.

There are different types of personal informatics systems in the market, such as pedometers, accelerometers, heart rate monitors, and systems like mobile applications and holistic activity managing systems (Table 4). These help people in creating versatile types of awareness. Holistic activity managing systems are more advantageous as these are combined versions of pedometers, accelerometers and heart rate monitors, some of which also have mobile applications.

Table 4. Types of Activity Tracking Tools

Type of PI	***Abilities***	***Drawback***
Pedometers	count steps	cannot take heart rate into account while tracking
Accelerometer	measure the amount of the people's movement	cannot take heart rate into account while tracking
Heart rate monitors	measure the heart rate especially when people do physical activities	are not comfortable enough to be worn every day
Mobile applications	tracking the activities manually or do the tracking itself through GPS	most of them do not work indoors and the user has to log indoor activities manually
Holistic activity managing systems	measure the calories burned through a mobile device, and give results through websites or mobile applications	*relatively advantageous for people in monitoring their physical activities*

As much as other type of behaviors, physical activity behavior is also complex (Caspersen, Powell, & Christenson, 1985); it depends on concerns of the person, but it is required to sustain life. As an early version of personal informatics systems, there are several research on the effect of pedometer usage on physical activity, showing that knowing about self "matters" in being active or increasing physical activity (Bravata Dm & et al., 2007; De Cocker, De Bourdeaudhuij, & Cardon, 2008; Rooney, Smalley, Larson, & Havens, 2003).

Li et al., (2010) discuss why personal informatics systems are an outstanding research area within HCI research. They state that, it becomes interesting as;

- These systems give information about self, while other technologies give information about the world
- They both collect behavioral information and enable people explore and understand that information
- What type of problems people experience with these systems are still unknown; these problems are critical for the design of future systems.

Accordingly, these systems have been explored by several researchers to discover effective ways to motivate people to be physically active. The research examples cover *mobile phone based, web based and product based systems*. The examples explained below also shed light on the research gap in personal informatics system research. However, these should not be regarded as the "best" examples, but stimulating ones.

2.4.1. MOBILE PHONE BASED SYSTEMS

Mobile phones are predicted to be the future of persuasive technology as people carry these devices everywhere and *witness* every action of their users (Fogg, 2007). With the potentials of mobility, in some research, mobile phones and music players are used as a part of personal informatics systems, as these devices can be used in public spaces without social interruption (Consolvo, McDonald, et al., 2009). Generally, mobile phone or music player work as the interaction basis of the system. The mobile device is wirelessly connected to an accelerometer or a pedometer so that counted steps can be turned into a motivational factor.

One of the examples of these systems is NEAT-o-Games (Fujiki et al., 2008) in which data is collected through a wearable accelerometer and logged wirelessly to a mobile phone. The data is presented in a virtual game. Game has multiple users and it aims to encourage users to become the leader among all users of the system. At the end of each day, champion of the day is announced, and

the winner gets a hint in another game-Sudoku. The connected games aim to encourage the users within a specific community. The system was tested with a small number of users who know each other, and the results shows that the system works well within the selected group.

Another example is Houston (Consolvo et al., 2006) and UbiFit Garden (Consolvo, Klasnja, et al., 2008; Consolvo, McDonald, et al., 2008). The second system is an iteration of the first system. In these systems, a pedometer is wirelessly connected to a specific mobile phone- Nokia 6600 (Figure 5). The pedometer counts the steps and communicates with the mobile phone. Similar to the previous example, this system also enables the user to receive feedback and share the progress of user with friends using the same system. Similar to the first example, in the second system, an application is installed in a mobile phone. Users interact with the system in which they "grow plants" as they get more active. The garden also runs on the phone as wall paper so that the user can always see the garden.

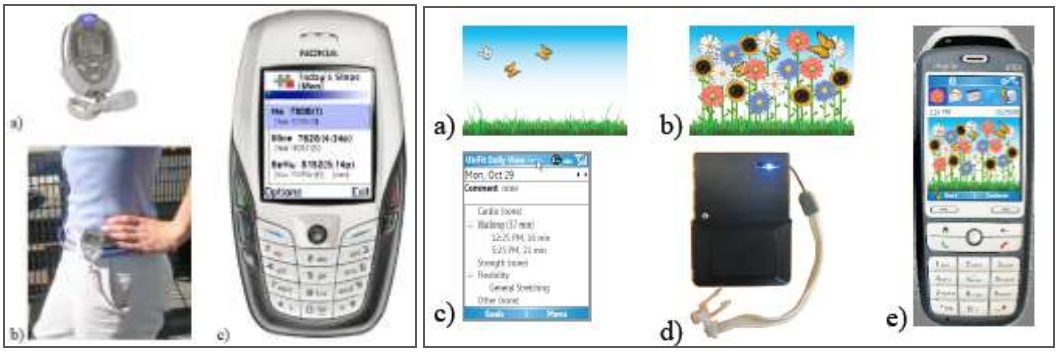

Figure 5. Houston system and UbiFit Garden systems (Retrieved from Consolvo et al, 2008, 2009)

Another example focuses on teenagers (Arteaga, Kudeki, Woodworth, & Kurniawan, 2010). The researchers try to encourage teenagers to do physical activity through games. The application uses the mobile device screen for interacting with the teenager, and expects the teenager to do the activities suggested in the game. After finishing the game, the teenager manually enters how much time s/he spent time on playing the game. If the time is below the recommended activity level, then the system launches motivational feedback to keep the user active.

Mobile diaries are also becoming popular as they can be downloaded directly to IPhone and Android phones. These applications actually do not automatically track physical activity, but user needs to allocate some time to log daily activity. An example of these systems is "wellness diary" (Ahtinen, Isomursu, et al., 2008; Ahtinen, Ramiah, Blom, & Isomursu, 2008). This system aims to work as mobile coach, and enables user to track weight, exercise amount and steps taken. The user should log the exercises by defining the intensity and duration of the activity. At the end, the system visualizes the logged data so that user can see the activity progress.

Figure 6. Wellness Dairy Screenshot (Retrieved from Ahtinen et al, 2008)

In relation to these, there is a tendency to develop personal-coach like mobile applications. As an example, Personal Performance Coach (Kass, 2007), collects personal data about its user's body and environment, analyzes the data and determines what user needs in terms of personal coaching. In addition, its smartness level includes instant and personal feedback on its user. However, this application is not specialized to physical activity, but it can help people in monitoring and shaping other kinds of behaviors (i.e., effectiveness of work hours or conversation habits).

These examples highlight the possibility of building applications that run in mobile devices. The given examples were built to understand user behavior towards mobile personal informatics systems. The results stress that users are positive towards using a mobile device to track behavior, however it is also stated that more research is needed to understand how these systems can lead to behavior change (Arteaga et al., 2010; Consolvo, Klasnja, et al., 2008; Consolvo, McDonald, et al., 2008; Fujiki et al., 2008).

2.4.2. WEB CONNECTED SYSTEMS

Web connected systems claim to encourage users by enabling social interaction among users of a single system. For instance, Sports Tracker (Ahtinen, Isomursu, et al., 2008) examines the effect of a mobile application together with a web sited connection, to understand experience of sharing data through a web site. The Sports Tracker application (Figure 7) collects data through GPS system while the user is doing outdoor activity. The data is logged to a website only if the user wants, and all users can see other users' progress and workouts through the website. Results of this study indicate that while some of the users feel that sharing the workout is a motivational factor, some refuse to share as they do not see any value to share the workout.

Figure 7. Sports Tracker Interface (Retrieved from Ahtinen et al., 2008)

In another study, how users would respond to sharing challenges is explored (Fialho et al., 2009). Researchers first make interviews with a small number of participants to understand participants'

feelings about physical activity. Finding that participants expect a system that can easily be connected to their daily schedule and prefer an expert or friends as a motivator, a web-based application called Active Share is developed (Fialho et al., 2009). Users of the website were able to define and accept challenges, give feedback about their own activity and make a comment on others' activities. As the previous example, the website aim of the website was to promote physical activity by enabling social share.

From another point of view, web-based systems can be criticized in success of these systems in promoting physical activity. For instance, in a longitudinal study, people were introduced a web based activity logging system, Impact (Li, 2009). People were first asked to just log their activities manually, but at the end of 7 weeks, people find it hard to log. When they were supplied with automated monitoring, it made people more curious about their data. The study also shows that logging the physical activity manually on a website can be a burden for the users (Li, 2009). In addition, based on a paper which explores the web-based physical activity promoting studies, it is concluded that using solely internet as a source of physical activity promotion is questionable in terms of their effectiveness in promoting physical activity; it requires special strategies to persuade people only through internet (Zhu, 2007).

Figure 8. Snapshot of IMPACT (Retrieved from Li, 2009)

2.4.3. PRODUCT BASED SYSTEMS

Final category of these systems is product based ones. The systems that use a specified product to log or capture people's activities are put into these group.

Fish 'n' steps (Lin, Mamykina, Lindtner, Delojoux, & Strub, 2006) is an example of product based systems. In that research, several users carry a pedometer which can be connected to a kiosk in a common area in the working space. The kiosk mainly shows the collected data when the pedometer is plugged in. Each user connects the pedometer to the kiosk to see the individual data through the interface (Figure 9) in which fish and tank metaphor is used. When the user takes more steps, the emotions, size and activity of a virtual fish also change. When the user does not take enough steps, then the facial expression of the fish changes to sad or angry, or the system removes the decorations in the tank.

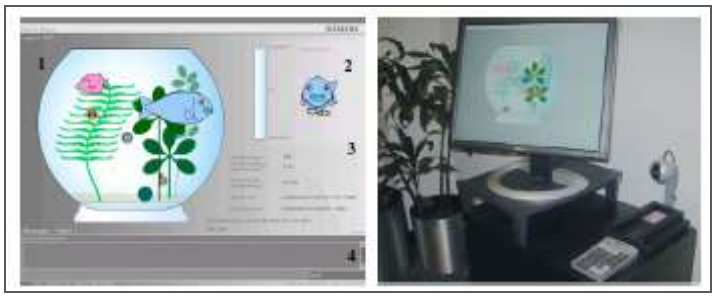

Figure 9. Fish'n Steps (Retrieved from Lin et al., 2006)

The example of Breakaway (Jafarinaimi, Forlizzi, Hurst, & Zimmerman, 2005) an interesting one. It is a kind of a sculpture that encourages users to get up and take a break at work (Figure 10). The sculpture was designed by considering four design goals: taking users' attention by data abstraction, showing the data in a non-intrusive way, enabling public data share and having an aesthetical pleasing display (Jafarinaimi et al., 2005). The study shows that the visual cues that the Breakaway gives about the sitting posture motivated the user to get up and take short walks.

Figure 10. Snapshot of Breakaway (Retrieved from Jafarinaimi et al, 2005)

The systems that use a product as a data measuring tool have already been commercialized. One of these examples is used in a study understand people's motivations throughout the day (Lacroix, Saini, & Goris, 2009). In that study, rather than measuring the effectiveness of the device, the researchers used the device as an objective data measuring tool (Lacroix et al., 2009).

Figure 11. Snapshot of Philips Activity Monitoring Device (Retrieved from Lacroix et al, 2009)

Similarly, another commercial product was used to understand whether feedback about physical activity and diet affects the success of weight loss (Shuger et al., 2011). Using the Sense Wear Arm Band, the researchers conduct a study with people who are in a weight loss program. They searched for the effect of using the technology by conducting the study with control groups. At the end, they find out that usage of technology has positive impact on weight loss as they found a significant weight loss within technology users in 9 months.

Figure 12. Body Media- Sense Wear Armband (Retrieved from www.bodymedia.com)

2.5. UNDERSTANDING USERS

The research examples indicate that, technology has been evolving very fast, and personal informatics systems are being developed both by researchers and companies. The examples also show that there is a tendency in designing game-like tools (i.e., UbiFit, Breakaway, Fish'n'Steps) to motivate people to be active. Considering that the new lifestyle of people lead to being less active, using technology, especially personal informatics systems, can be considered as an effective way of motivating people. It is observed that, in recent years, mobile products and mobile phones have been utilized to inform people about self (See Appendix B for a comprehensive list of commercial products).

When persuasive technology literature is taken into consideration, the potential of personal informatics systems as persuasive technologies is more clear: These can serve to increase human capacity *(tools)* by giving information about self, create social relations *(social actor)* by enabling social interaction and enrich personal experiences *(medium)* by motivating people with prompts or suggestions. Moreover, they suggest more intimate and personal interactions than any hand-held mobile product or technological system. The experience that the user has with personal informatics systems may constitute different dimensions.

Li (2009) states that in order personal informatics systems to be useful, they should engage the user in at least one of the stages of use. The research examples lead to commercialization of these systems and these tools are being introduced into the market gradually. The research on these systems either focuses on problems of system usage, developing effective physical activity monitoring systems or effectiveness of using such systems as interventions (Maitland & Siek, 2009).

As stated, all the listed systems mainly aim to explore the effectiveness of a designed tool or game, and how users react toward the system rather than understanding the dimensions of whole user experience. No research has been encountered exploring the user experience of these tools in a holistic way. However, HCI and design research should also focus on how users experience these systems and how people can become more engaged so as to overcome the barriers of doing physical activity through this technology (Maitland & Siek, 2009). Uncovering the user needs will help researchers to gain better understanding of when users choose to use the system, in what ways the system can help the user and how users wish to use the system. Thus, the persuasive qualities of personal informatics systems needed to be explored in relation to *user experience*, for discovering the dimensions of system-user interaction for supplying better motivation.

CHAPTER 3

USER EXPERIENCE

While a decade ago, the main emphasis was on understanding users' functional needs, in recent years the focus has been shifted from usability needs to user experience (Hassenzahl, 2008). In the last decade, understanding users' functional, physical and emotional needs has become one of the main challenges of design. Researchers have developed several models, such as interaction, product and technology centered models, to represent different user needs. The literature of usability turned to be user experience literature, therefore, even though it is more than that, the user experience is said to be about the experience of interactive products (Carroll & Mentis, 2008; Forlizzi & Battarbee, 2004; Hassenzahl, 2008).

3.1. DEFINITIONS AND DIMENSIONS OF EXPERIENCE

User experience brings a holistic perspective on user-product interactions. Even though various definitions are made, a common ground is observed in defining the dimensions of experience. As a starting point, ISO (2010) defines user experience in basic terms as; *"a person's perceptions and responses that result from the use or anticipated use of a product, system or service"*(Figure 13)

The earliest definition of "experience" Alben (1996) defines it as all aspects of using an interactive product covering how people feel about it, how well people understand its functions, how it makes people feel when using it, how it fits its purpose and context of its use. In a very recent research, a group of researchers tried to make a shared definition of UX (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009), by asking as special group of people who work on UX (Law, Roto, Vermeeren, Kort, & Hassenzahl, 2008). They come to a conclusion that UX can be scoped to; "*systems, products, services and objects that people interact with through an interface*." (pg.727). However, explorations in UX literature show how this definition can be portrayed as incomplete. In one of the most comprehensive one, user experience is stated (Vermeeren et al., 2010); *"to be generally understood as inherently dynamic given the ever-changing internal and emotional state of a person and differences in the circumstances during and after an interaction with a product"* (pg.521)

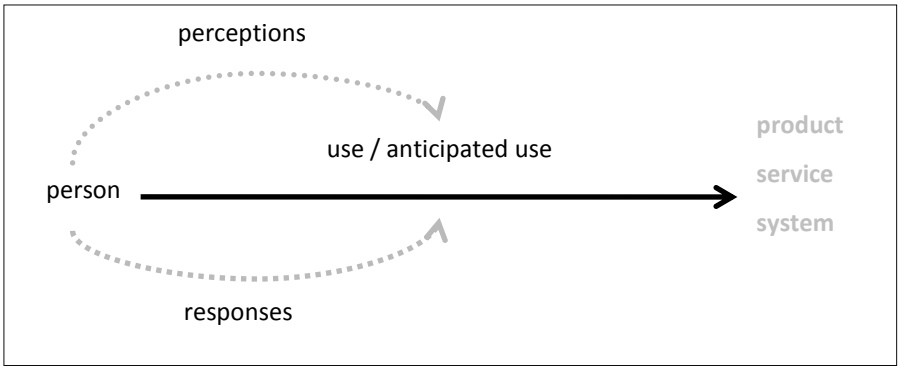

Figure 13. Visualization of ISO definition of UX

Most of the definitions in UX literature covers, interactive products or systems, users and responses towards products before-within-after interaction. Experience has a subjective nature and it covers users' perceptions of products as well as the emotional responses of users and the situations that

experience take place (Hassenzahl, 2008). Mainly, user experience of an interactive product can be defined to include interactions of the user before, during and after use of the product (Alben, 1996; Forlizzi & Battarbee, 2004; Roto, 2007) covering all aspects of experience such as physical, emotional, sensual, cognitive and aesthetic (Demirbilek & Sener, 2003; Forlizzi, 2008; Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006; Norman, 2003), including the user, product and the context of the interaction (Alben, 1996; Hassenzahl, 2005).

There is wide variety of definitions of user experience in literature and this diversity depends mostly on the approach of the researchers. Forlizzi & Batterbee (2004) groups these approaches in three (Figure 14): *(1)* product-centered models, *(2)* interaction-centered models and *(3)* user-centered models. These approaches will be considered separately in detail in the following sections. It should be noted here that, these models are not totally different from each other, but are intertwined. The common point of these models is that they explain the experience by understanding the interaction between the functions and aesthetics of the product/system and users' responses towards product/system. Some of these models cover the time, place and environment of the experience, while most of these models focus solely on the interaction between product and people which result as the resource of experience (Forlizzi & Battarbee, 2004).

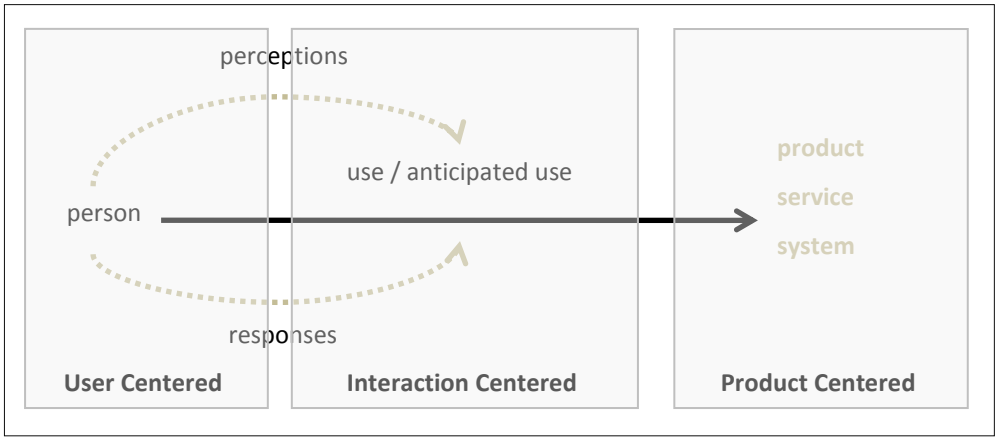

Figure 14. Approaches in UX Literature (Reproduced from Forlizzi and Batterbee,2004)

3.1.1. PRODUCT-CENTERED EXPERIENCE

These models take the product at the center of experience and try to explore how a single product is experienced. Forlizzi and Batterbee define these models as "*describing the kinds of experiences and issues that must be considered in the design and evaluation of an artifact, service, environment, or system*" (Forlizzi & Battarbee, 2004, p.262).

In product design, experience refers to the affective response of a person during the interaction with a product (Demir, Desmet, & Hekkert, 2006; Hekkert & Schifferstein, 2008). According to Demir et al. (2006), interacting with the product covers instrumental (e.g. using, operating), non-instrumental (e.g., playing with) and non-physical (e.g., remembering) interactions. The experience of the user with the product is shaped by both the characteristics of the user (e.g., personality, skills, background) and the product (e.g. color, shape, texture) (Demir et al., 2006). In addition, the context in which the interaction takes place also influences the product experience (Desmet & Hekkert, 2007).

To give an overall framework on what product experience is, Hekkert (2006) states three components of product experience: aesthetic experience, experience of meaning, and emotional experience. The framework is explained by Desmet and Hekkert in detail (2007) and is supported by design researchers as listed:

Aesthetic experience is defined as the capacity of the product to please one or more of the people's senses such as being beautiful to look at, pleasant to hear, smell or touch (Desmet & Hekkert, 2007).

In relation, the product experience models include explorations of all product qualities, such as experience of visual appearance of products (Harold, 2008; Hekkert, 2006), tactual qualities of products (Sonneveld & Schifferstein, 2008), experience created by product sounds (Egmond, 2008; Özcan & Egmond, 2006) and experience of product smell (Cardello & Wise, 2008). The product experience based on five senses of users contribute to holistic approach of product experience, since the product experience is multisensory and each product quality contributes to overall experience of the product (Schifferstein & Spence, 2008).

Experience of meaning, which is an outcome of cognitive process, comes into prominence when people assign metaphors, personality or other expressive characteristic to the product, such as defining a product as luxury as a representation of status and lifestyle (Desmet & Hekkert, 2007). In other words, the products convey meanings about their owners and these meanings also contribute to how a product is experienced (Demirbilek & Sener, 2003; Rompay, Hekkert, & Muller, 2005).

Finally, *emotional experience* is the feelings and emotions that are elicited by the product during the interaction between the user and the product, such as feeling desire to a new car model (Desmet & Hekkert, 2007). The study of Desmet (2003) explores how a product evoke emotions, and at the end he states that there are 12 emotions that a product can evoke. After Desmet introduced his thesis on product emotions, the topic attracted design researchers, for the explorations of product qualities that evoke specific emotions, such as boredom (Aart, Salem, Bartneck, Hu, & Rauterberg, 2006) and fun (Cila & Erbug, 2008), as much as a holistic exploration (Demir, Desmet, & Hekkert, 2008).

In summary, product centered models break down the experience by focusing on the attributes of products and interactions that product attributes afford (Figure 15). Mainly, product-centered models deal with the "affective responses" that products evoke as a result of instrumental, non-instrumental and non-physical interactions. Even though the characteristics of the user affect the product experience, the core influential of the experience is product characteristics. In relation, users' affective responses are the results of the experience of aesthetics of, meanings attached and emotions evoked by the products.

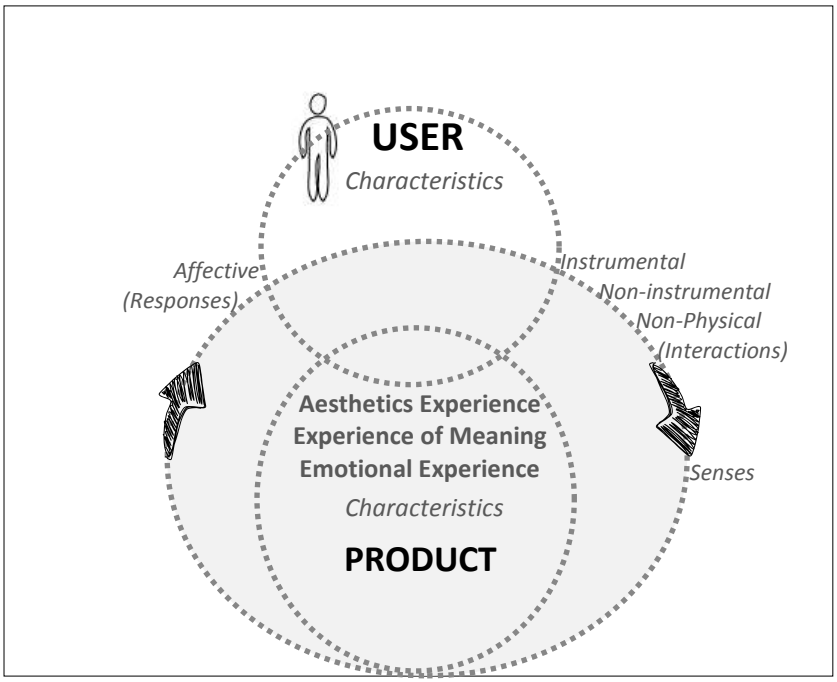

Figure 15. Main Components of Product Centered Experience

3.1.2. INTERACTION-CENTERED EXPERIENCE

For this type of experience, the core of the experience is the interactions with products or systems. They mainly focus on the users' engagements with the products within the engagement environments, and experiences as an outcome of this engagement.

One of the examples of interaction-centered models is the model of Forlizzi and Batterbee (2004). They state that there are three ways in which user-product interactions occur; fluent, cognitive and expressive. *Fluent interactions* are subconscious ones, and do not require attention on the activity; they are mostly automatic and well-learned ones like riding bicycle. *Cognitive interactions* focus on the hands-on experience. They need cognitions, and may result in change in user, such as knowledge or confusion and error. Trying to identify how bath tab works in a foreign country is an example of cognitive interactions. Finally, *expressive interactions* help the user formulate a relationship with the product, for creating an expression via the product, such as setting a background image for the computer screen. Defining these interactions, the types of experiences that these interactions result in were also identified as "experience, an experience and co-experience" (Forlizzi & Battarbee, 2004; Forlizzi & Ford, 2000). *Experienc*e is the purest form of experience, which is like self-talk' or "self-expression" and happens when people have conscious interactions with the products. *An experience* has a beginning and an end, and this type of experience may result in changes of behavioral and emotional states of users. *Co-experience* is not a direct experience of a product, but sharing the experience with other users in social environments. This type of experience can impress people's further experience with the same product as sharing experience can result in new interpretations on users.

With interaction-centered models, social experience plays an important role. It is because, beings social beings, people need to share experience. Sharing the experience of a product is a part of social experience, even the product is not in the shared environment (Battarbee, 2003). The experience can be narrative, but the social experience can result in adoption of a product, as the experience creates a social context to talk about and share.

Another model of interaction-centered experience models is the model defined by McCarthy & Wright (2004). According to the model, there are four threads of experience (Wright, Wallace, & McCarthy, 2008). The *compositional thread* is about the how the elements of experience come together to create a whole experience. *Sensual* thread is about the sensual engagement of the user with the product, how the product' look or how the texture make the user feel. This thread is similar to the aesthetic experience described in product-experience model. *Emotional thread* is about the emotional outcome of experience a product; how the experience make the user feel. This thread is also similar to the emotional experience level of product-experience model. *Spatio-temporal thread* is about the effects of time and place: the experience with a product always changes as the time and place changes. The listed threads are processed by users within 6 processes (McCarthy & Wright, 2004).

- users *anticipate* an interaction create connections with previous experiences;
- *connect* the interaction situations with previous experiences without conscious thinking;
- *interpret* what is going on and how the experience makes user feel like;
- *reflect* what is happening during an interaction and evaluate the outcomes;
- *appropriate* the interaction in terms of other experiences and sense of self;
- and *recount* the experience with storytelling or telling stories of the experience.

The important point in interaction-centered models is that it covers social experience of users. By telling about the interaction they have with products, users share their experience with others. Besides, the experience can be shared when several people interact with products within the shared environment. Therefore, social environments and place of interaction become integral components of interaction centered models.

Another important component of interaction-centered models is the time of interaction. In time, the social environment of interaction can change. Moreover, these models take "after-interaction" when explaining the experience. In addition, the user is possible to change in terms of moods, attitudes and behaviors as a result of time effect.

To cover up, interaction-centered models of experience focus on the form of interactions and the context of interaction (Figure 16). Mainly, they deal with sub-conscious, hands-on and expressive interactions. While these models do no focus on the characteristics of either the user or the product, it is known that both effect how the interaction is formed. The user tries to understand the product, connects with it and reflects the experience. At the end, users' sensual, emotional and behavioral responses affect the way the user recounts the experience. As stated, time and context of interaction as well as other people within the interaction context are critical influential of appropriation of interaction.

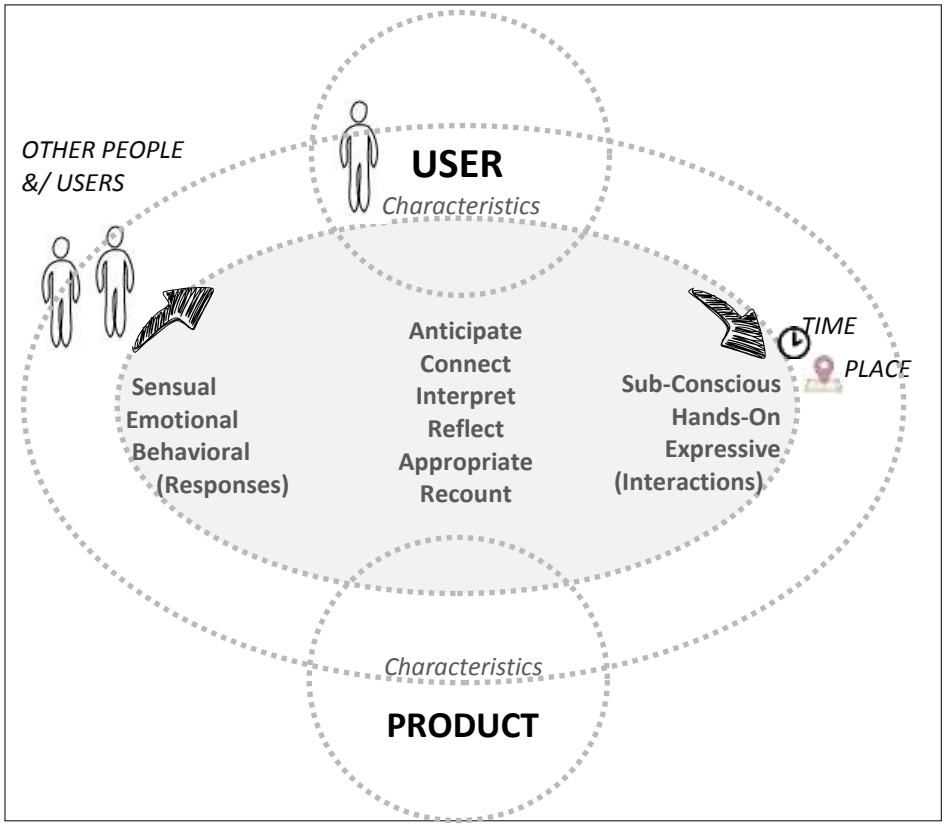

Figure 16. Main Components of Interaction Centered Experience

3.1.3. USER-CENTERED EXPERIENCE

These type of experience covers all the aspects of an experience that a user encounters when using a product or system. In recent years, modeling "users' experience" has become the focus of researchers in relevant areas to create design guidelines (Law & van Schaik, 2010). In fact, user-centered models of experience are constructed to understand the *users* of designed systems to provide guidelines for user centered design (Bargas-Avila & Hornb, 2011). In these models, user's goals, actions, expectations and personal needs are studied altogether to create an understanding of how people experience systems. Users are social beings and they need to connect and stay connected to with other people within experience (Carroll & Mentis, 2008).

Hassenzahl's (Hassenzahl, 2005) model is an example of these kinds of models. In an earlier article, Hassenzahl (2008) defines user experience as:

> *"UX is about technology that fulfills more than just instrumental needs in a way that acknowledges its use as a subjective, situated, complex and dynamic encounter. UX is a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organizational/social setting, meaningfulness of*

the activity, voluntariness of use, etc.). Obviously, this creates innumerable design and experience opportunities."

Considering the "designed systems" as one of the core components of user-centered experience, it is designers' responsibility to design for experience. It is obvious that designers have the power to give character to their products or systems (Hassenzahl, 2003, 2008). They can define product content, functionality and interaction type. However, they must ensure their creative intentions are perceived by the users in the same way. As a basic example, if the product is designed for creating communication between people, this feature should be experienced in that way. Users perceive two main qualities of products: pragmatic and hedonic qualities (Hassenzahl, 2003). While pragmatic attributes of products are related to the product functionalities, hedonic attributes measure the user's well-being and psychological goals. While hedonic qualities are "motivators" of positive experience, pragmatic qualities are "hygienic factors" which remove the barriers but not direct source of positive experience (Hassenzahl, Diefenbach, & Göritz, 2010). This also supports the idea that, even in interactive products, which are considered as pragmatic tools, users look for hedonic attributes to fulfill psychological goals (Diefenbach & Hassenzahl, 2011).

In another user-centered experience model, properties of the system, characteristics of the user, task and context form the interaction characteristics (Mahlke, 2007). When users interact with the system, they perceive instrumental (i.e., controllability, effectiveness) and non-instrumental (i.e., visual aesthetics, haptic) qualities of a system which results in emotional reactions (i.e., subjective feelings, expressions) (Mahlke & Thuring, 2007). At the end, all the reactions and perceptions form the appraisal of the system (i.e., users' overall judgments, their usage behavior, choice of alternatives). This model covers the time-factor indirectly considering that perceptions can affect usage decisions, and appraisal of the system can affect future decisions of users. In relation, appraisal of the system can lead users to either keep using the system or choose other alternatives.

Considering all these, it can be implied that users' experience of a system is formed by both usability (instrumental or pragmatic qualities) and aesthetics (non-instrumental or hedonic qualities) of the system equally (Roto, 2007; Schulze & Krömker, 2010). The context in which the user is in affects the way user experiences a product or system (Hassenzahl, 2008; McCarthy & Wright, 2004; Wright, McCarthy, & Meekison, 2005). Therefore, it becomes hard to "design experience", but still designers need to answer "why, what and how" questions in order to understand people's do and be goals and conceptualize experience (Hassenzahl, 2011).

In summary, user centered models frame the experience by focusing on human-centered aspects of it (Figure 17). As stated, emotions, personality, attitudes and motivations of users affect the way they interact with a system. They utilize a product or system to satisfy their do (pragmatic) and/or be (hedonic) goals. Therefore, functions, aesthetics and expressions of the system serve for satisfaction of user needs. Interaction results in emotions, behavior and attitudes and these can be influential of users' future choices. In addition, the context of experience as well as the time of interaction affects the way the system is experienced.

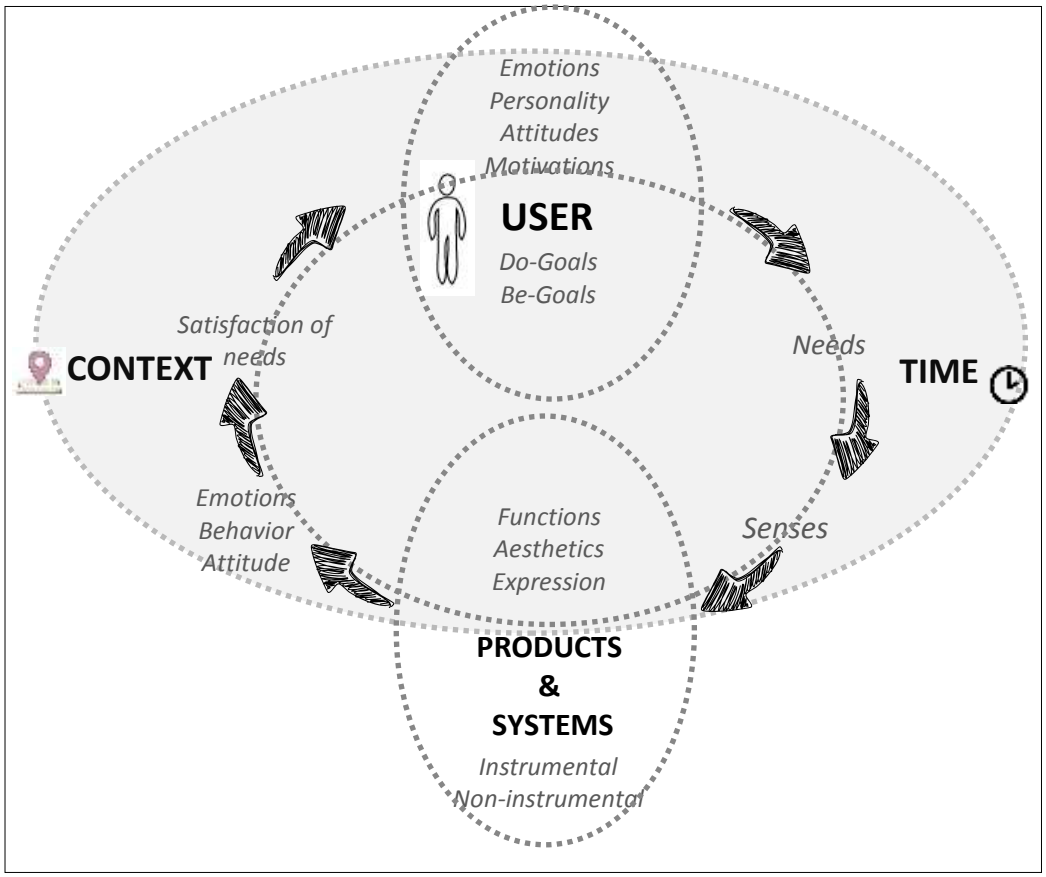

Figure 17. Main Components of User Centered Experience

3.1.4. UNDERSTANDING EXPERIENCE FROM HOLISTIC PERSPECTIVE

All the listed models in previous sections contribute to understanding the dynamics of experiencing technological products. Those models have common points, even though they offer different terminology. Since the main elements of experience are product and the user, all are constructed by the dynamics of user-product interaction. The difference is only resulted from the perspective of the researchers. These coincidences and differences can be listed as follows:

- All models take the qualities of the product as the resource of user response.
- All allege product characteristics as the resource of emotions while conceptualizing experience.
- User-centered models and interaction-centered models define context of use and time as a significant influential of experience, while product centered models do no put emphasis on context or time.
- Product-centered models cover all products regardless of being technological products, but interaction and user centered models cover only technological products.

Considering the similarities into account, a new and holistic picture of user experience can be drawn (Figure 18). Even though the previous models focus on user, product/system or interaction, it can be concluded that all have equal importance in explaining user experience. It should be noted that, this overall picture does not illustrate the new definition of user experience, but covers up all models explained above.

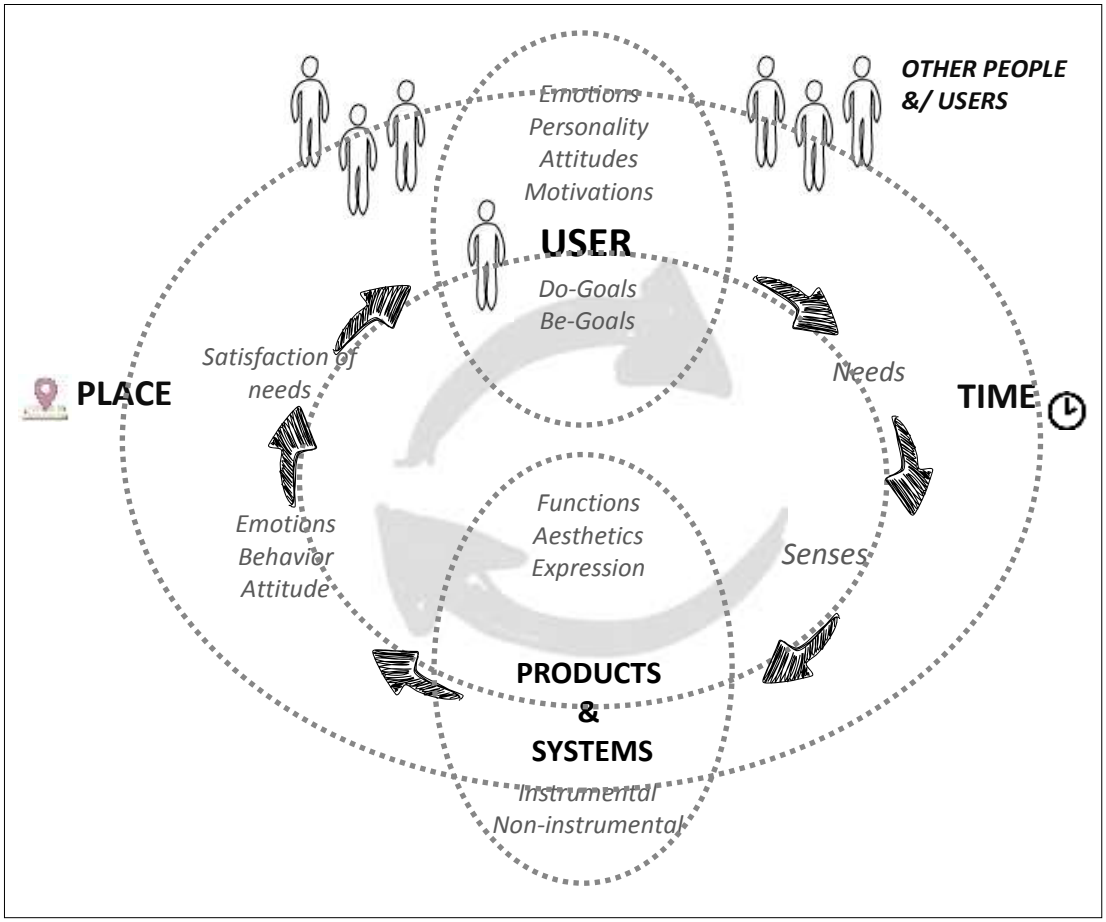

Figure 18. Holistic Approach for User Experience

As can be followed from Figure 18, user experience of technological products/ systems is affected by emotions, personality, attitudes and motivations of the user and functions, aesthetics and expressions (instrumental or non-instrumental qualities) of the product or system. The user has do-and-be goals and needs, and the product/system is designed to satisfy user's needs. The user experiences a product/system through senses of the users and those affect the way the product/system is perceived and experienced.

Once the user interacts with the system, with several changes in user, each experience affects the way the user experience other product/systems. At the very beginning, the user interacts with the product/system, user's emotions, behavior and attitude changes which is closely related with satisfaction of needs. It is because, at the end, the user appropriates the experience, and the experience can result in abandonment or permanence of usage. This initial experience has also influence on user while choosing other alternatives, and further experience is affected by the initial perceptions.

Thinking that users are social beings, user experience cannot be isolated from the context of use. The place where the user is in, the time of experience and other people around are the major determinants of the context of use. All these can change the way people experience a product/system. In addition, some of the systems/products can be co-experienced; therefore, other users of the product/system become the prominent component of user experience.

All these imply that experience is not a one-time phenomenon; it can change in relation to context and time. Therefore, it is dynamic; it changes in relation to the context over time. In addition, it depends on the users' perceptions, thus it is subjective.

3.2. EXPERIENCE AND ACCEPTANCE OF TECHNOLOGICAL PRODUCTS

Encouraging people for doing physical activity and having healthy behavior started to be one of the new focuses of HCI literature (Ahtinen, Isomursu, et al., 2008; Fialho et al., 2009; Klasnja, Consolvo, & Pratt, 2011). People want to be healthy and fit, but as they get inactive and have poor eating habits, they encounter with serious health problems (Steven N Blair, 2009; Pietiläinen et al., 2008). This situation creates a discrepancy between the actual and desired lifestyles. It is challenging because unhealthy habits of people threat their life, and technology can shift this threat into a win. As stated in Cognitive Dissonance Theory (Cooper, 2007), when people have discrepancy between the attitude and behavior, they tend to create a change either behavior or attitude. At this point, as creating behavior change through technology positively has been attained challenging for HCI researchers, understanding behavior becomes promising. As stated in the previous chapter, HCI literature utilizes psychology to understand human behavior so as to design for encouraging people to have healthy life. Understanding how people change behavior, various applications are being developed for enabling people to monitor their own activities (Ahtinen, Lehtiniemi, & Hakkila, 2007; Consolvo, Klasnja, McDonald, & Landay, 2009; Li, 2009). However, one of the main arguments of technological developments is that, a critical user-related component of these technologies is ignored. While trying to change behavior, technology impacts the user's social world (Consolvo, McDonald, et al., 2009). When the user tries to integrate the technology into daily life, it affects the flow of everyday life. Therefore, a general understanding of how people integrate these technologies in daily life, and how daily life is affected by this integration is a critical question. User experience (UX) literature is a good starting point for analyzing the dimensions of this integration as the main concern of UX is to understand users.

The expectations of users change with new technologies, in the sense that interacting with these products require satisfaction of needs beyond the functional needs (Hassenzahl, 2008; Nurkka, Kujala, & Kemppainen, 2009; Stelmaszewska, Fields, & Blandford, 2004). Understanding users' functional, physical and emotional needs in relation to user experience has become the center of most of the user studies in the last decade (Helander & Tham, 2003; McCarthy, Wright, Wallace, & Dearden, 2006; Roto, 2007; Stelmaszewska et al., 2004). Reading the means to satisfactory user experience provides researchers with principles and guidelines to create products with physically and emotionally rich experience and interactions.

Keyson (2008) states that, experience is a part of acceptance process, and to be integrated into daily lives, technological products need to have pragmatic values such as functionality, as well as hedonic values such as playfulness and personal expression, through which products gain personality and behavior within experience. Keyson (2008) defines three key factors for experiencing intelligent products:

- First, the user should feel that the total control of the product is up-to-him. In other words, while product is giving suggestions, controlling for the environment and taking action, it should not contradict with user needs and expectations (Norman,2007 in Keyson 2008) .
- Second, the product should be emotionally appealing and engaging. Personalization of the product is listed as the important aspect of intelligent products to be considered as engaging, since personalization creates challenge with saving user from boredom (Csikzentmihalyi, 1975, in Keyson 2008).
- Finally, the product should fit the expected and perceived functional performances. Performance is mainly about the physical properties of the product (i.e., pragmatic qualities) and the perceptions and real use should not be contradicted for successful intelligent product experience.

The explanation of technological product experience is similar to what have been explained up to here, but the main difference is that, Keyson puts emphasis on engagement of the technological product in order to save the user from being bored. To sustain engagement, Keyson suggests that the product should be personalized to keep the user interested in the product.

As Keyson states (2008), positive user experience is important factor of accepting a technology. In order designers to benefit from the technology most, and enable them to accept it, how people accept

technology needed to be examined. As a starting point, technology acceptance has been the focus of many researchers since the first Technology Acceptance Model was developed by Davis (1989).

3.2.1. TECHNOLOGY ACCEPTANCE

Technology Acceptance Model of Davis (1989) takes the Theory of Reasoned Action as bases, (Fishbein & Ajzen, 1975), and focuses on two theoretical constructs. Perceived usability, which is the user's impression of effort required to use the application, and perceived usefulness, which is the user's perception of performance. Venkatesh and Davis (2000) developed an extended version of the TAM to identify the external variables influencing perceived usefulness, which is the core of the model, and is determined by the user's subjective norms, voluntariness of use and perception of usability. Perception of usability itself was determined by the user's perception of external control, level of computer anxiety and level of fear of technology; as well as by the user's desire to play and explore the technology, the user's perceived enjoyment and computer playfulness. A combination of these factors determines whether or not users will use the systems (Venkatesh & Davis, 2000).

With this model in mind, a number of researchers investigated several related determinants that affect the technology acceptance. For instance, two studies examining the influence of subjective norms on behavioral intention find different results (Chau & Hu, 2002; Hu, Chienting, & Chen, 2005). Hu et al. (2005) show that subjective norms do not influence behavioral intention, while Chau and Hu (2002) show that it does. Other researchers studied determinants of intention to use (Chau & Hu, 2002; Gong, Xu, & Yu, 2004; Hu et al., 2005), attitude (Shih, 2004), perceived usefulness (Chan & Lu, 2004; Hu et al., 2005) and perceived usability (Chau & Hu, 2002; Gong et al., 2004; Shih, 2004). Özer, Tore, and Erbug (2009) list the determinants of technology acceptance categorized by different researchers under four main topics:

- Technological factors (i.e., perceived usability, task-technology fit, job relevance, related advantage).
- Contextual factors (i.e., training, facilitating conditions, task characteristics and voluntariness of use).
- Individual factors (i.e., gender, age, education level, professional orientation, perceived enjoyment/use, etc.).
- Social factors (i.e., subjective norms, social influence, social pressure, image and visibility).

Within these findings, however, researchers do not completely agree on which perceived quality (or qualities) most significantly affects user acceptance of technology. Moreover, the technology acceptance literature (Legris, Inghamb, & Collerette, 2003; Sharp, 2006) documents attempts of determining the antecedents of perceived usefulness and perceived usability (Chung & Tan, 2003; Davis, 1989; Hackbarth, Grover, & Yi, 2003). Most such studies are restricted to web-page and software programs, however. The importance of a TAM for on-body interactive products lies in understanding the reasons *behind* the acceptance of technological systems. With respect to these factors, perceived usability and usefulness of on-body interactive products can be regarded as the main determinants of user acceptance. On-body products, however, suggest different interactions compared to the usability and usefulness of hand-held personal products or technological systems (Edwards, 2003; Thomas, 2008; Weber & Buurman, 2005). For this reason, the acceptance patterns of on-body interactive products will be different (Edwards, 2003; Thomas, 2008). On the other hand, understanding acceptance of these products will be easier if combined with experience literature and visual appearance rather than through visual appearance exclusively.

The importance of technology acceptance model for personal informatics systems lies beneath understanding the reasons behind the acceptance of technological products and systems. Thinking that personal informatics systems are new types of personal-technological products, perceived ease of use and usefulness can be regarded as two main acceptance determinants of users. Failure in perceived ease of use would result in rejection to use these systems. On the other hand, these systems suggest different interactions as they carry the characteristics of hand-held, technological, personal and mobile products. Thus the technology acceptance model would be benefitted in exploring the dimensions of experience of these systems to have a holistic approach.

3.3. USER ENGAGEMENT AND ENGAGING EXPERIENCE

In an introductory paper of the announcement of interaction design awards, Alben (1996) states the criteria for being noteworthy to interaction design and valuable to users as "experiences that are successful and engaging". Similar to fun (Cila & Erbug, 2008; Hassenzahl, 2003) and enjoyable (Kim, Park, Hassenzahl, & Eckoldt, 2011; Roto, 2007) user experience experience, engaging experience has been discussed as a component that should be internal in experience. Early research by Overbeeke et al (2004) state that products should engage users through their "physicality"; products should be fun to use, and thus, be engaging. Therefore, the goal of the designer should be ensuring the users to have fun with the product. Overbeeke et al (2004) defined five aspects that are essential for understanding engaging experience, which are:

- Functional possibilities and performance of the product
- The user's desires, needs, interests and skills (perceptual-motor, cognitive and emotional)
- The general context of use of the product
- Richness with respect to all the senses
- Possibility to create one's own story and ritual

Engaging experience relates to users' skills of "knowing, doing and feeling" (Overbeeke et al., 2004). The experience of technological products also covers dimensions in each level, such as aesthetics, interactivity, pleasure, functionality and social issues. In this sense, process of engaging experience is based on and related to "cognitions, motor skills and emotions" of users.

It is designers' responsibility to make things engaging and thus making users engaged with products. However, being engaging can be regarded as an attribute of experience, rather than a totally different form of experience. In a recent research, user engagement of systems (O'Brien, 2008) is defined as:

> *"Category of user experience characterized by attributes of challenge, positive effect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, interactivity, and perceived user control."*

User engagement is strongly connected to how a system can attract and sustain user interaction through aesthetics, interaction and use, and by evoking positive emotions and challenges. User engagement is not a single phenomenon; it evolves with the process of product use. This process covers engagement, non-engagement-disengagement and reengagement (O'Brien & Toms, 2008). Overall *engagement* is defined as the user experience of a product. When the novelty effect passes, users may *disengage* with the product. If, after a while, the user desires the experience and starts using the product again, *reengagement* occurs. Understanding the overall engagement process will take time, thus user engagement can be defined as a longitudinal process in which user's reactions towards the product can evolve over time. This definition, however, is made based on user studies of websites, which ignores physical product use and its social aspects.

Chou and Conley (2009) define engaging experience as product's ability to inspire more frequent, active and intense interaction. The product needs to attract the user's attention, keep his or her interest, and make the user think about the product more frequently. Chou and Conley (2009) define engaging experience as a value of a product in addition to usability and aesthetics. However, this definition is relatively narrow as this definition focuses on engaging experience only during use.

From a broader perspective, Flow Theory (Csikszentmihalyi, 1988, 1990) defines the way people highly involved in certain activities. Even though flow theory initially covered performance artists, the facts explained can be used to explore why people are involved in using products. Csikszentmihalyi defines flow as:

> *"The state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it. (pg 4)*

Accordingly, people will be in a "flow state" while performing some activities, if they have time and potential to focus on the activity. The skills of the individual and the challenges of the activity define

the level of flow: if these two are at equally optimal levels, then people will be in flow (Figure 19). They feel anxiety if the level of challenge is high, but their skill level is not high enough to match these challenges. On the other hand, people feel bored while performing an activity if the challenges of the activity are low but their skill level is higher than the activity requires. It is evident that the level of flow increases when the user has the control of the activity.

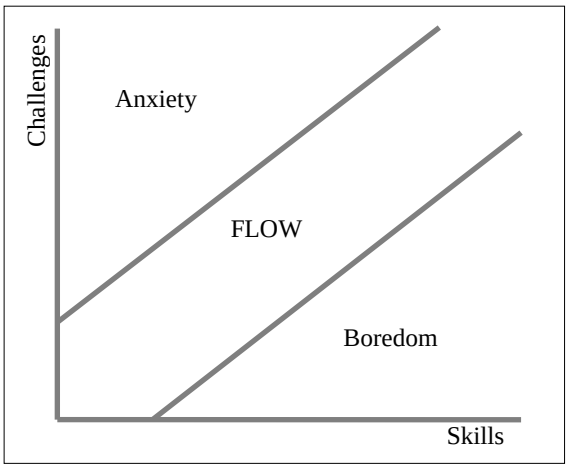

Figure 19. Flow Experience (Reproduced from Csikszentmihalyi, 1990)

Considering the scope of this thesis, engaging experience is required to help maintain sustained use of a system. Sustained use of a system is likely to support positive behavior change, which in turn contributes to people's well-being. Maintaining the continuity of product use is important to motivate people to maintain a desired behavior, such as taking regular walks everyday by using a pedometer. These systems should keep the user at engagement level for long time to meet the desired behavior. Therefore, understanding why people move from engagement to disengagement (O'Brien & Toms, 2008) with a system could provide insights about continuity of desired behavior. Moreover, they should keep the user in "flow" (Csikszentmihalyi, 1988, 1990) by matching the challenges with user skills. However, most of the systems currently in use are subjected to usability tests to understand the usefulness of the system, rather than exploring how the system should offer engaging experience. There is still an opportunity to offer engaging experience with the personal informatics systems, by offering functions such as sharing data, tracking physical activity, logging activity and getting feedback about oneself.

3.4. TEMPORALITY OF EXPERIENCE

The nature of experience is that it is temporal, dynamic and it changes over time (Hassenzahl & Tractinsky, 2006; Karapanos, Zimmerman, Forlizzi, & Martens, 2009, 2010; Mahlke, 2007; Vermeeren et al., 2010). It is clear that the initial perceptions of a product change, as the user becomes familiar with the product when the initial novelty passes away.

Roto (2007) mentions about the dynamism of experience by adding the "before interaction" phase. It is stated that at the beginning, the user has initial expectations for product and these perceptions affect the way the product is experienced. These perceptions are affected by the brand image, advertisements, friends and reports. User's earlier experience with similar products also affects user's expectations. The important point Roto (2007) touches on is that, looking from the business perspective, what matters is that users' longitudinal experience rather than a one-time experience of the user. Therefore, user experience should cover changes users' attitudes and emotions rather than the responses during interaction.

Karapanos et al. (2009) draw out temporality of experience. Temporality is presented in three phases: familiarity, functional dependency and emotional attachment. The user first gets familiar with the product, explores its functionality, and develops an attachment to it (Figure 20). *Orientation* relates to

discovering new features or having problems learning how to use the product. *Incorporation* is when the product becomes meaningful for the user. *Identification* is related to user's personal experience. In daily life, the product becomes part of both one's daily routine and social life; therefore users have the chance to express themselves through the products they use and make relationships with.

Talking about the temporality of experience and to design for it, understanding how it changes over time becomes important. Recently, there is a common understanding that UX should be evaluated before, during and after interaction (Vermeeren et al., 2010). While technology companies used to measure their products to understand whether they fit the usability and functional requirements (Väänänen-Vainio-Mattila, Roto, & Hassenzahl, 2008), a common understanding arouse recently that methods for evaluating and designing for experience is needed (Kort, Vermeeren, & Fokker, 2007).

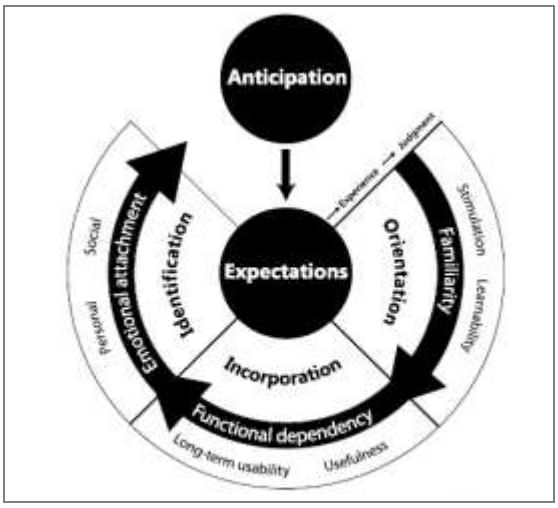

Figure 20. Model of Experience over Time (Karapanos et al., 2009)

In relation to the aforementioned facts, measuring longitudinal experience is critical to understanding it. In early years of user experience research, the common research method was to just measure experience after the user interacts with the product/system. However, in recent yerars, user experience research has been shifted from collecting data about one time product experience to long term use (Karapanos et al., 2009, 2010).

3.4.1. MEASURING LONGITUDINAL USER EXPERIENCE

A number of methods have been borrowed from psychology that can be used for collecting self-reports. Interviewing the participant after they use a product is one way to understand the overall experience of product use. However, it is especially critical to distinguish the changes over time.

Väänänen-Vainio-Mattila et. al., (2008) summarize the requirements for UX evaluation methods as (pg3):

- *Valid, reliable, repeatable*
- *Fast, lightweight, and cost-efficient*
- *Low expertise level required*
- *Applicable for various types of products*
- *Applicable for concept ideas, prototypes, and products*
- *Suitable for different target user groups*
- *Suitable for different product lifecycle phases*
- *Producing comparable output (quantitative and qualitative)*

- *Useful for the different in-house stakeholders*

There are several methods that have been developed in recent years. For instance, the *UX curve* (Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, & Sinnelä, 2011) is a method where users recall their experience with a specific product. Given an empty "curve" sheet, users are asked to draw the change in their experience over the period of product use and justify the changes in the curve. While this method is easy to apply, it is based on memory rather than recounting experience in the moment.

Cultural probes are another method used to measure experience (Gaver, Boucher, Pennington, & Walker, 2004; Jaasko & Mattelmaki, 2003). Participants are given a set of products, such as a diary, disposable camera, voice recorder etc, and are asked to report on product usage in the wild. Even though this method provides valuable insights about product use and the social experience that unfolds, it is hard to analyze. Participants rely heavily on their imagination and to complete the probe (Gaver et al., 2004). Probes, initially aimed to inspire designers for new ideas, were adopted by several academic and design groups. However, the developers of it stated that cultural probe data shouldn't be analyzed for justifying the design ideas (Gaver et al., 2004).

Diaries are a common method used to gather experiences of product use. Using diaries, participants can both be asked to rate and write about their experience. There are three types of time-related reports of experience: *time-based, fixed schedules and variable schedules* (Bolger, Angelina, & Eshkol, 2003). Using *time based designs*, participants are asked to report their experience at random, fixed or a combination of times. Using *fixed schedules*, they give reports at fixed-time schedules; for example, at 9PM at every evening, or every hour of the day. They can also be asked to report their experience using *variable schedules*. The time interval between each report is extremely important, as filling out too many reports can be a burden for participants. For time-based and fixed intervals, the burden is relatively small as the time of reporting is predictable while the burden can be bigger in asking at random times, as the time of report is not intrusive (Bolger et al., 2003).

The *Day Reconstruction Method* is an example of a *time-based schedule*. Here, participants are asked to recall their experience from the previous day and describe it in a sequence of episodes (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004). The aim of this method is to understand both the context and the circumstance of the experience, while participants can report the experience by constructing the importance of it within their daily life. For example, to understand the experience of a smart phone over time, participants are asked to report about it at the end of the day.

The Day Reconstruction Method was inspired by the e*xperience sampling model* (ESM) (Csikszentmihalyi & Csikszentmihalyi, 1988; Csikszentmihalyi & Hunter, 2003). ESM is an example of a *variable schedule*, as participants are asked to report their experience at random and estimated times. ESM aims to understand the "context and content of the daily life of the individuals" (Hektner, Schmidt, & Csikszentmihalyi, 2007). Since participants are queried at random times, aspects of experience may be missed and a burden may be imposed on respondents (Kahneman et al., 2004).

Event Based Diaries (Bolger et al., 2003) ask participants to report on experience the moment that it unfold. This method also runs the risk of disrupting actual experience. In addition, this method is also participant-dependent, as people can forget to report something and try to recall it later. All in all, these research methods offer a number of possibilities for collecting data about user experience over time.

Considering the longevity of experience, it is not possible to utilize one single method to capture the overall experience (Väänänen-Vainio-Mattila et al., 2008). Rather, exploration and evaluation of UX can and should cover more than one method to maintain the richness of user data.

3.5. EXPERIENCE OF PERSONAL INFORMATICS SYSTEMS

As stated in Chapter2, personal informatics systems are becoming a popular research domain as they attempt to motivate people to be active in daily life, to lead them to a healthy life. Research done on these systems mainly focuses on mobile applications, online systems and on-body products. The companies, therefore, do not produce a single product only, but a holistic system that user experiences. In order to provide the experience holistically, including ways to motivate people, it is noteworthy to understand user experience particularly for personal informatics systems.

User experience literature roughly provides the key points for understanding the user experience of personal informatics systems. The overall picture drawn at the end of 3.1 can be utilized to capture the major determinants of UX of these systems. However, this knowledge still needs to be associated with user research to understand what users need and how they experience personal informatics systems.

Personal informatics systems have traditionally been designed by considering users' functional, social, interactive and personal needs. It is well known that these systems should foster curiosity, be interactive and consider social values (Ahtinen, Ramiah, et al., 2008), and to ensure this, the systems should have qualities that motivate people to change their behavior. For example, regular feedback and updates are a way to keep people engaged in product use (Ahtinen, Isomursu, et al., 2008). Adding curiosity and playfulness to a system is also an important factor, as curiosity and playfulness will make the system dynamic rather than static (Ahtinen, Ramiah, et al., 2008). The quality of the presented data is also an important factor (Ahtinen, Ramiah, et al., 2008; Consolvo, Klasnja, et al., 2009), as well as the way the data is collected.

Previous works show that the systems should provide good experience, engage the user, and support interactivity (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Consolvo et al., 2006). In this vein, Maitland and Siek (2009) state that, in order to challenge users to keep doing regular exercise, design of these systems should address effective and engaging user experience. Recent studies on personal informatics show that there is a gap in explorations of two interrelated factors of behavior change: social and engaging experience. Social influence on usage, social motivation, attention, data sharing and integration of system into daily life are important for continuation of system usage (Ahtinen, Isomursu, et al., 2008; Consolvo et al., 2006; Consolvo, Klasnja, et al., 2008; Consolvo, Klasnja, et al., 2009; Fialho et al., 2009; Klasnja et al., 2011; Maitland, 2011). On the other hand, engaging experience keeps the user motivated and curious, by rewarding the user and personalizing the interaction (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Lacroix et al., 2009).

In the light of findings from previous studies, focusing on the user experience will help designers understand how to design products that motivate and engage people to change their behavior. The following two studies will explore the user experience of personal informatics systems in order to provide knowledge for future designers and researchers of these systems.

CHAPTER 4

METHODOLOGY

This chapter focuses on the methodology of the studies. General overview of the methodology will be explained, followed by the research method of each study. The chapter will end with data analysis plan of the studies. In the following two chapters, the results of the studies will be discussed in addition to the models suggested at the end.

4.1. QUESTIONS TO BE ANSWERED

The aim of the studies is twofold. First study explores how people experience personal informatics systems, how they would like to experience it, and how the characteristics and qualities of personal informatics systems would lead to awareness and motivation. Finding that people unwell to use the system at the end of the first study, second study explores the dimensions of user engagement with personal informatics systems. The main aim of these studies is to figure out the dimensions of use experience to sustain usage for creating long-term awareness and motivation.

The questions that were answered through each study are as follows:

STUDY 1

The aim of the first study is to answer the main question:

1. What are the dimensions of early experience of personal informatics systems? *(Experience related)*

This main question will be answered through the sub-questions:

1. What are the characteristics and qualities (dimensions) of personal informatics systems required for creating awareness? *(System Related)*
2. What are the human-centered effects of using the system? *(User related)*
3. How can people be motivated to sustain usage of personal informatics systems? *(Time related)*

STUDY 2

The aim of the second study is to answer the main question:

2. What are the dimensions of user engagement to sustain usage of these systems? *(Experience related)*

This main question will be answered through the sub-questions:

1. What is the role of system qualities of personal informatics systems in user engagement of these systems? *(System Related)*
2. What are the human-centered results of using the system in the long term? (*User related)*
3. How does people's evaluations of the system change in long term usage? *(Time related)*

As shown in Figure 21, the questions focus on finding out the (i) system related, (ii) experience related and (iii) time related dimensions of using personal informatics systems. Thus, the studies require participants to *use the system* before explaining their needs and expectations. At the end, two models explaining (i) dimensions of early experience and (ii) user engagement are suggested. These models give evidences of key points to be considered in design of personal informatics systems. The flow and outcome of each study will be explained in the following sections.

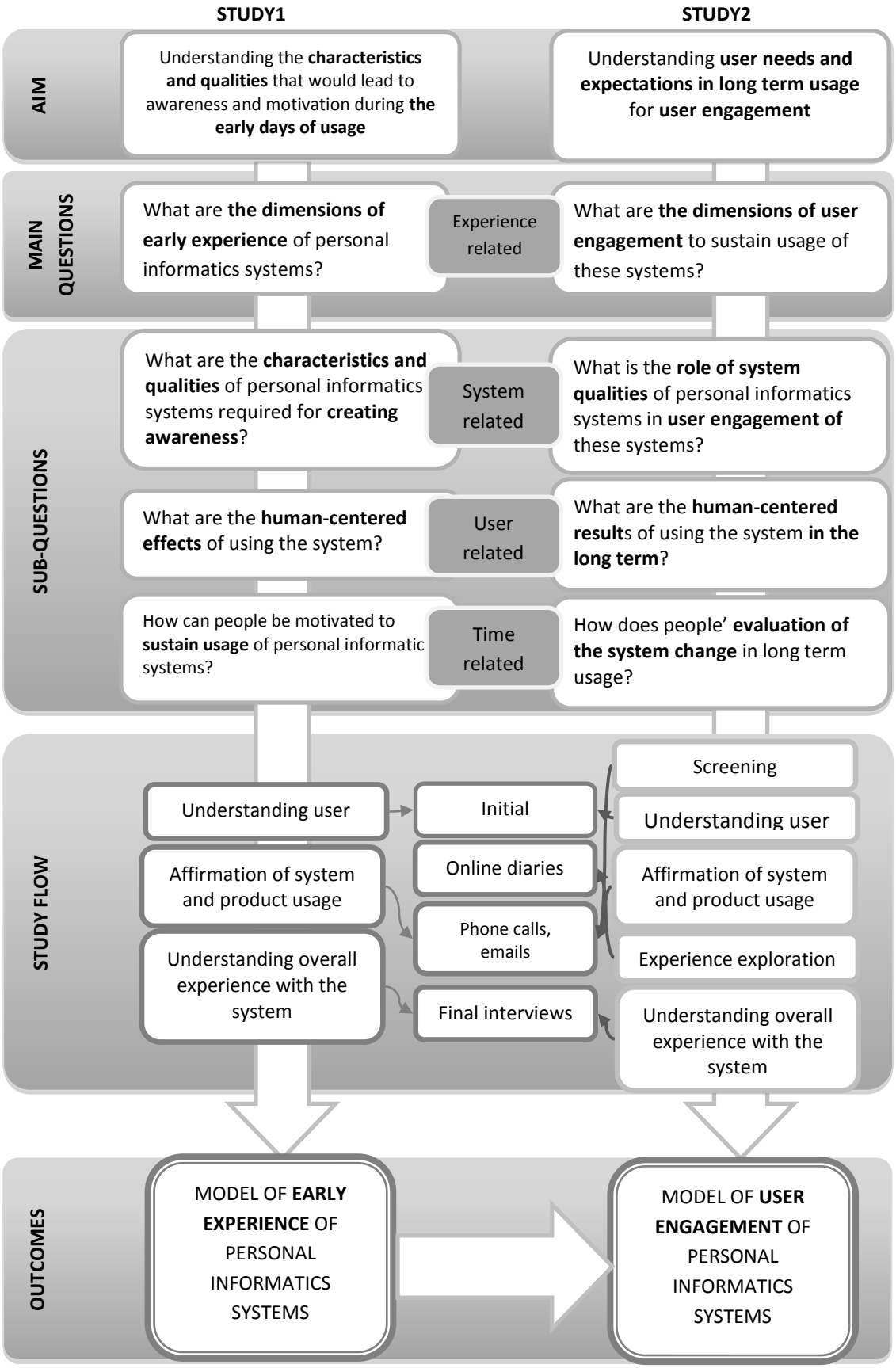

Figure 21. Overview of the Methodology

4.2. FIRST STUDY

First study was designed to explore the needs and expectations of people and dimensions of early experience of personal informatics systems. The research questions focus on how people experience personal informatics systems, and how they would like to experience it, the characteristics and qualities that would lead to awareness and motivation. The study covers several steps in order to figure out the knowledge about:

1. **Characteristics and qualities required to create awareness:** The first study figures out the characteristics that would play role in creating awareness by analyzing people's needs and expectations in early days of usage. User expectations further give the important qualities that can make people motivated to keep using the system.
2. **The changes in people's attitudes towards the system and their behavior:** People's attitudes towards a product or system can change after using it. In addition, user's perceptions about using other products will change after using a specific product. The changes, especially after using a system that aims to create awareness, can be evident before and after using a product. People's impressions towards the system together with people activities behaviors will be explored to understand whether using the system create any change in their attitude.
3. **User needs and expectations to make people motivated to sustain usage of these systems:** As was discussed in Chapter 2, motivation of the person is the determinant of attitude change (Petty & Cacioppo, 1986; Petty et al., 1995) as well as behavior change (Ajzen, 1991; Bandura, 2001; Fishbein & Ajzen, 2005). It is also apparent that products become part of daily routines after a while (Karapanos et al., 2009), however, when it comes to personal informatics systems, it is especially important to sustain long-term usage to get the most benefit from them. Therefore, users' needs and expectations play important role in sustaining usage of these systems.

Dimensions of early experience of personal informatics systems (Main Finding)*:* These tools are still in evolution and these are new for users. In experience of novel products, the user first gets familiar with the product, explores its functionality, and develops an attachment to it (Karapanos et al., 2009). Therefore, understanding how people initially experience these tools can contribute to the design of future ones. Thus, it is essential to explore and define how people experience during the first days of use.

It should be noted that the focus of the first study is not on finding strategies for changing behavior, rather on understanding the *product-centered factors of creating awareness*. Thus, the emphasis of this study is on understanding *the product characteristics for making people aware of* their *physical activity*, and this will first be explored through early user experience. In relation, the theories explained in the previous chapters assist this study to focus on strengths and weaknesses of these tools in motivating people to be aware of their activities. At the end of the study, the model of early experience of personal informatics systems is suggested to explain the system qualities people expect as results of early days of usage.

4.2.1. PRODUCT SELECTION

As explained in Chapter 2, there are several types of personal informatics systems. The available systems were listed to select the appropriate one. Selection criteria was listed as; ways of carrying the device, working principles of the system and ways of reaching personal data.

When the systems listed were compared (Table 5), it was observed that, Philips Direct Life and FitBit work in similar ways; they have small forms and work like pedometers; can be clipped on users' clothes or be put in their pockets. However, Nike Plus is totally different from these, as it requires special Nike shoes (the sensors are put into the hole designed for the sensor) and it can only be used when the user is wearing those shoes. Body Media system works like a combination of different types of data collection tools. It was also speculated to be the most accurate of the products in the market (www.bodymedia.com). In addition, the website of the company gives references to various studies conducted with the system, including clinical ones that indicate the accuracy and usefulness of the system. Considering all these, Body Media system was selected as the system of the first study.

Table 5. Details of Available Holistic Personal Informatics Systems (May 2011)

Name of the System	***Visual***	***Form of Device Carrying***	***Working Principle***	***Application***	***Online System***
Philips Direct Life		Clip-like	Like an accelerometer, Portable part tracks the quality of activity by measuring the movements in three dimensions	Yes	Yes
Body Media		Armband	Combines pedometer, accelerometer and thermometer, Sensors have to touch the skin of the user to track more accurate results.	Yes	Yes
FitBit		Clip Like	Like a pedometer Counts steps and makes estimations of calories burned	Yes	Yes
Nike Plus		In the running Nike shoe	Like a pedometer Tracks the intensity of steps	Yes	Yes

At the time of the study (May2011), the selected system had three versions: armband only, armband with a display, and armband with Bluetooth Technology (Figure 22). First version is the basic model, in which the armband requires to be plugged in the computer and be synchronized to reach the data. The second version includes a portable display in addition to the armband: the user could see a number of steps taken through the display. The third version has Bluetooth Technology which can be used to synchronize the device with the smart phone to reach data, but the user has to have a Bluetooth enabled smart phone. Bluetooth connection only creates a possibility to reach data instantly; the device still needs to be plugged in the computer to see the related progress graphs. Still, it ensures an additional technology for people to reach their data. Thus, Bluetooth enabled version was selected to increase the availability of reaching data.


Figure 22. Three Models of Body Media Fit

4.2.2. STUDY DESIGN

The study was designed as a 1-week study in which mixture of quantitative and qualitative methods were applied (see Table 6 for the details), and Study 1 was conducted in Ankara, Turkey between June-August 2011. With respect to the "time" concerns of holistic user experience models explained in Chapter 3, the study covers 3 stages: before (Stage 1), during (Stage2) and after (Stage3) use. Details of each stage will be listed in relevant sections.

Table 6. Stages of the Study and Outcomes

What will be found	***Explanation***	***Qualitative Method***	***Quantitative Method***	***Stage(s)***
User profiles	Users at different stages of physical activity be evaluated by using scales		Stages of Change Scale	1-3
System characteristics	Users' first and final impressions		Non-verbal Pictorial Scale	1-3
	Users' opinions about the product and system characteristics	Interview Questions	Characteristics of On-Body Interactive Products	2-3
	The characteristics that may affect sustained motivation and usage	Interview Questions		3

Stage 1: This stage started with a brief introduction of the study. Participants were asked to fill the Stages of Change Scale (see 4.2.3 for details). Once finished, they were asked to wear the device on the arm and were then shown the online system. They were assigned a system user name and password. The ones, who had android or IPhone, were asked to download the application. Those participants were also shown how to sync the device with the mobile phone. Afterwards, participants were asked about their first impression of the device. Participants were then asked if they had any questions about the system or study. This stage generally lasted between 30 to 45 minutes in total.

***Stage 2*:** Two days after the initiation of the usage process, participants were called and asked questions about product usage. They were also asked if they have any problems with the product/system. If the participant reports a problem, it was tried to be solved by trying to understand the source of the problem. The reports of this stage were recorded by the interviewee by taking notes. This stage lasted between 5 to 15 minutes in total.

Stage 3: After a brief introduction, participants were given Stages of Change Scale once more. Filling that, they were given the Characteristics of On-Body Interactive Products Scale (see measurement tools for details). Each participant was asked to fill the questionnaire by reading the question loudly and while filling, they were encouraged to talk about their ratings and ideas freely with specific

questions on the ratings. They were also asked to talk about system revisions they expected. At the end, participants were asked to fill the non-verbal pictorial scale once more. This stage lasted between 55 to 75 minutes in total.

4.2.3. MEASUREMENT TOOLS

During the study, 3 scales were used to achieve (1) understanding the participants' physical activity behaviors, (2) understanding participants' first and final impression and (3) helping participants evaluate the system and explain their expectations.

Stages of Change Scale

At the beginning and at the end of the study, physical activity levels of participants were learned. In the literature, Stages of Change (Marcus & Forsyth, 2003) scale is used for this purpose The scale is in English originally, but Turkish version of it was already developed and validated (Cengiz, 2007; Cengiz, İnce, & Çiçek, 2009). By applying this scale both at the beginning and at the end of the study, participants' physical activity levels, as well as changes in their activity levels (if there were any) were learned (See Appendix B for both Turkish and Original versions of the Scale).

Non-verbal Pictorial Scale

At the beginning and at the end of the study, participants were asked to report their first and final impression towards the product with a nonverbal pictorial-scale (Desmet, Overbeeke, & Tax, 2001). The graph was developed by design researchers to understand responses towards products. As it has clear visualizations and can be easily interpreted, it was selected to have quick responses about the impressions of participants towards the system. (See Appendix C for the original version and version used during the study).

Characteristics of On-Body Interactive Products

At the final stage of the study, participants were asked to rate the system qualities through a previously developed scale. "Characteristics of On-Body Interactive Products Scale" was applied with small changes in the scale (Appendix D). The scale was developed and validated during the EDS559-Test Construction course in 2010 by the author. In the original version, there were 72 items with 7 dimensions. However, to eliminate unrelated and incoherent items, and shorten the time of evaluation process, items that had correlations less than 0.4 were eliminated. Each item of the scale was asked to be rated in terms of its importance and satisfactoriness, as for the study collecting the importance of the system qualities were also important. The questions were asked in 7-point scale. The original version of the scale is in Turkish, but English Translations have also been made, to inform the readers about the content (See Appendix D for the Original and English versions of the scale).

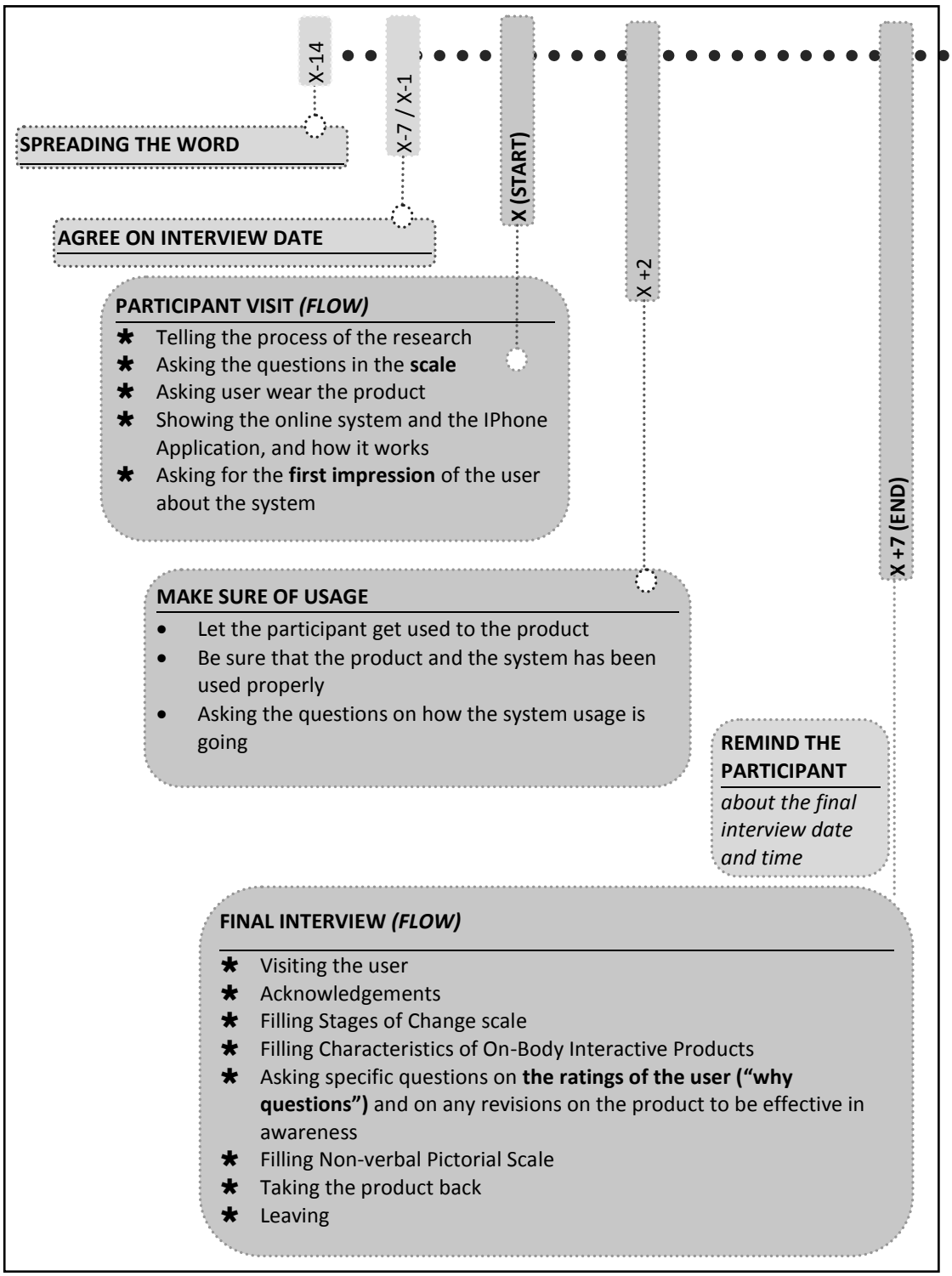

Figure 23. Flow of the Study1

4.2.4. SELECTION OF PARTICIPANTS

The participants were recruited through email, phone or word of mouth. All of the participants were unaware of presence of the system and all encountered the product for the first time. Voluntariness to be a participant was the first selection criteria, thus, Snow Ball sampling method was applied (Biernacki & Waldorf, 1981). At the beginning of the study, a short recruitment text was sent to people that might be interested in. Once started conducting the study, several people wanted to be a participant, as they either were in progress of losing weight, would like to lose weight, that care about their physical well-being or were curious about their physical activity levels. Therefore, even though the selected product had Bluetooth-enabled data synchronization function, having an IOS or Android mobile phone was not listed as selection criteria. At the end, only four of the participants had either IPhone or Android Phone. While conducting this research, a family physician was also kept in touch and one of the participants was his patience.

The participants were first contacted through email or phone to explain the aim of the study. Once the participant accepted to be a participant, an interview was scheduled. When the first interview was conducted, another time period was set for the final interview.

In total, 20 people (10 female, 10 male) participated in the study, with ages ranging from 20 to 55, and with a mean value of M= 36.20 (Table 7). The number of people in age groups and gender was equally distributed in order not to make a group of people dominate the results.

Table 7. Distribution of Ages in the First Study

Ages	*Female*	*Male*	*Total*
20-29	3	4	7
30-39	3	4	7
40-55	4	2	6
Sum	10	10	20

4.2.5. VENUE AND EQUIPMENT

The face to face interviews were conducted either in participants' houses or at their offices or at the researcher's office. All the interviews were voice recorded with permission. The phone interviews were not voice recorded, but the researcher took notes where required. The study did not require any other special setting. For the study, participant were also issued a generic email account (such as user1@gmail.com) to login the system which enabled the study to be controlled better.

4.2.6. SETTING- ABOUT ANKARA

The study was conducted in Ankara, Turkey, the second biggest city and capital of the country. The study was conducted between 15th of July and 25th of August, 2011. It was summer and the temperature was between 30^{0}C and 40^{0}C.

4.3. SECOND STUDY

Second study was designed to explore the dimensions of user engagement with personal informatics systems. It was also aimed to understand people's experience of different types of personal informatics tools, covering the wearable and desktop activity monitoring systems, and their awareness over time. The research questions focus on how people are engaged / disengaged with personal informatics systems, and the characteristics and qualities that would lead to awareness and motivation over time. The study covers several steps in order to figure out the knowledge about:

1. **The role of system qualities of personal informatics systems in user engagement of these systems**: People's experience of system qualities in long term usage gives insights on what people expect from these systems in relation to their engagement. It is expected that this information will highlight positive and negative relationships between the system qualities and their engagement over time.

2. **The changes in people's attitudes towards the system and their behavior:** The activity behavior changes, especially after using a system, that aims to create awareness, can be evident before and after a longer time period. Thus, people's activity-behaviors will be explored to understand whether using the system create any change in people. People's initial goals and final achievements will also be identified to interpret the human centered results of using the system.
3. **Changes in people's experience of personal informatics systems in long term usage**: As was stated, in experience of novel products, the user first gets familiar with the product (Karapanos et al., 2009). After a while, people discover new features of the product, or they have problems in learning how to use the product; and the product becomes part of both one's daily routine and social life; therefore users have the chance to express themselves through the products they use and make relationships with (Karapanos et al., 2009). It is apparent that, when the initial novelty of the product wears off, people's expectations will change over time and the study will explore these.

Dimensions of user engagement to sustain usage of these systems (Main Finding): It is very well-known that motivation is a prominent factor in behavior change (Ajzen, 1991; Bandura, 2001; Fishbein & Ajzen, 2005). To keep people motivated and aware of their physical activity behavior over time, it is especially important to sustain long-term usage. Focusing on user engagement, second study aims to dig the dimensions of user engagement to sustain usage of these systems.

4.3.1. PRODUCT SELECTION

To select the products, the products and systems that were on the market at the time of the study were explored (See Appendix E for the full list of these products). In total, 15 mobile systems (which include a mobile device and an application and/or a website) and seven standalone mobile applications were reviewed. In addition, two products, one scale and one sports band, were also added to the list, to see the potentials of future products. Taking the limitations of the previous study into account, it was decided to use different systems that offer various types of user interactions. In addition, three main criteria were set to support my final decision:

1) Mobility: In the previous study, it was learned that carrying the product was a concern in terms of physical interaction with the product. Thus, the form of carrying the device was one of the criteria.

2) Ways of interacting with personal data: In the previous study, it was also learned that accessing data was a problem. This study aims to make sure that users would have the flexibility to interact with the system whenever they want. Therefore, instant access to data was a second concern.

3) Usefulness of data: Usefulness of the data is tightly connected to interactivity and mobility of the device. Therefore, types of personal data users can check or log is another criterion of product selection. In relation, through personal informatics tools, different types of personal data can be tracked (i.e., calories burned, calories eaten, steps taken, total distance taken, sleep quality etc.) by either smartness of the system or by requiring users' logs (i.e., food, activity, manageable health parameter such as weight and total body fat ratio). Different types of data that was decided to be taken into account while selecting the systems.

Considering these and the systems that were currently in the market, three different systems were selected (see Table 8).

Table 8. Selected Systems and System Properties

System	***Mobility***		***Interacting with Data***			***Data***			
	Device	Phone	App	Online	Device	Activity	Food	Sleep	PHM
Body Media	✓		✓	✓		✓	✓	✓	✓
FitBit	✓		✓	✓	✓	✓	✓	✓	✓
Daily Burn		✓	✓	✓		✓	✓		✓

System 1- Body Media (BM) (Figure 24**):** As was stated in the first study, Body Media system works like a combination of different types of data collection tools. The system consists of a wearable part, an application and online activity manager system. The wearable part automatically tracks the calories burned during daily activities. It measures calories, steps, sleep quality and track this data. The information tracked can be managed with product' online activity manager or can be seen instantly through synchronizing data through Bluetooth. This system was purposefully selected as people living in US might have different suggestions and ideas about using this system.

Figure 24. Body Media System

System2- FitBit (FB) (Figure 25**):** As was briefly explained in Study-1, FitBit has small form and works like pedometers; can be clipped on users' clothes or be put in their pockets. Device tracks the calories burned during daily activities and monitor the quality of sleep. Similar to Body Media, this system also measures calories, steps, sleep quality and track this data. The information tracked can be seen through the small screen of the tracker instantly however, details of daily data can only be tracked through the online system. The reason for selecting FitBit Tracker is that it shows real-time activity statistics so user can know how close s/he is to defined goals.

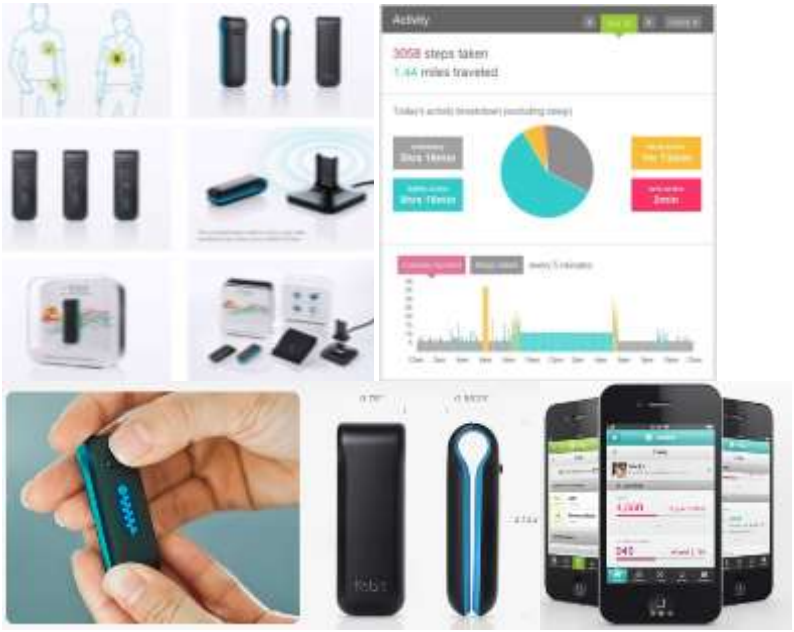

Figure 25. FitBit System

System3-DailyBurn (Figure 26): Daily Burn Tracker is different from the previous systems as it does not have a specific device to carry, rather user can track the activity or food data through logging the system. It provides fitness plans, nutritional tracking, and social motivation to help user reach their health and fitness goals. User can log food and activities to the system to see how many calories burned and taken. The reason for selecting Daily Tracker is that user does not have to carry another device to track their personal informatics; rather carrying their phone and logging in is the only way to interact data. The system gives rough information to the user to make the user aware of their body.

Figure 26. Daily Burn System

4.3.2. STUDY DESIGN

The study had 5 main stages (Detailed flow of the study can be followed from Figure 27, it was designed as a 5-weeks study in which mixture of quantitative and qualitative methods were applied. The study covers one initial step and 5 main stages: understanding user profiles (Stage 1), first interview (Stage2), familiarization (Stage3) and during use (Stage4) and after use (Stage5).

Initial Step: A recruitment text was spread to find potential participants (See Appendix F for the recruitment text). It was posted around Carnegie Mellon University (CMU) campus, Craigslist, coffee shops and sent by emails.

Stage 1: Once people responded, they were asked questions about themselves to further understand their availability (See Appendix G for the screener text). People's age, gender, physical activity level and phone type were learned at this stage. If the participant was eligible, they were set a mutually agreed upon time for the first interview.

Stage2: The initial interviews were 45 to 90 minutes semi-structured interview where participants were asked the get-to-know questions, about the details of their physical condition, and their current physical activity level (See Appendix G for initial interview questions). Note that not all these questions are relevant to the study but were asked to start the initial conversation. After that, participants were introduced the system and asked to use a physical activity tracking tool that they were assigned.

Stage3: The first week was familiarization week. Participants were asked to use and try to integrate the tool into their daily life. If participants will have any interaction problems with the system, they were helped to solve them (See Appendix G for Sample Questions).

Stage4: After first week, participants were expected to keep using the product for 4 more weeks. Participants were also encouraged to keep tracks of any insights they gain about your condition. Throughout 4 weeks, participants were asked to report their experiences every day. A Qualtrics survey was created on Carnegie Mellon University's (CMU) database and was sent to participants via emails, at the same time of each day. Participants were first asked to write about their experience for the previous day and rate their experience. Coming close to the end of the 5 weeks, participants were asked to state a time for the final interview (See Appendix G for Survey Questions).

Stage5: Final interviews were held at a mutually agreed upon location such as the CMU campus or participants' offices, but daily reports was done remotely on the phone or online. Final meetings also took between 45 to 90 minutes. This stage covered detailed questions about participants' experience with the system. The survey questions were asked again to get the overall idea of people. Their needs and expectations were also asked to maintain their engagement with the system. All the questions that were asked during the interviews are attached in Appendix G.

Table 9. Stages of the Study and Outcomes

What will be found	***Explanation***	***Qualitative Method***	***Quantitative Method***	***Stage(s)***
User profiles	Users at different stages of physical activity be evaluated by using scales		Stages of Change Scale	1-5
	Getting-to-know the users	Interview Questions		2
System characteristics	Understanding familiarization	Interview Questions		3
	Users' experience over time		Experience and System Characteristics Evaluation Questionnaire	4
	The characteristics that may affect sustained motivation and usage	Interview Questions		5
	Understanding reasons for scores, and evaluation of overall experience	Interview Questions	Experience and System Characteristics Evaluation Questionnaire	5

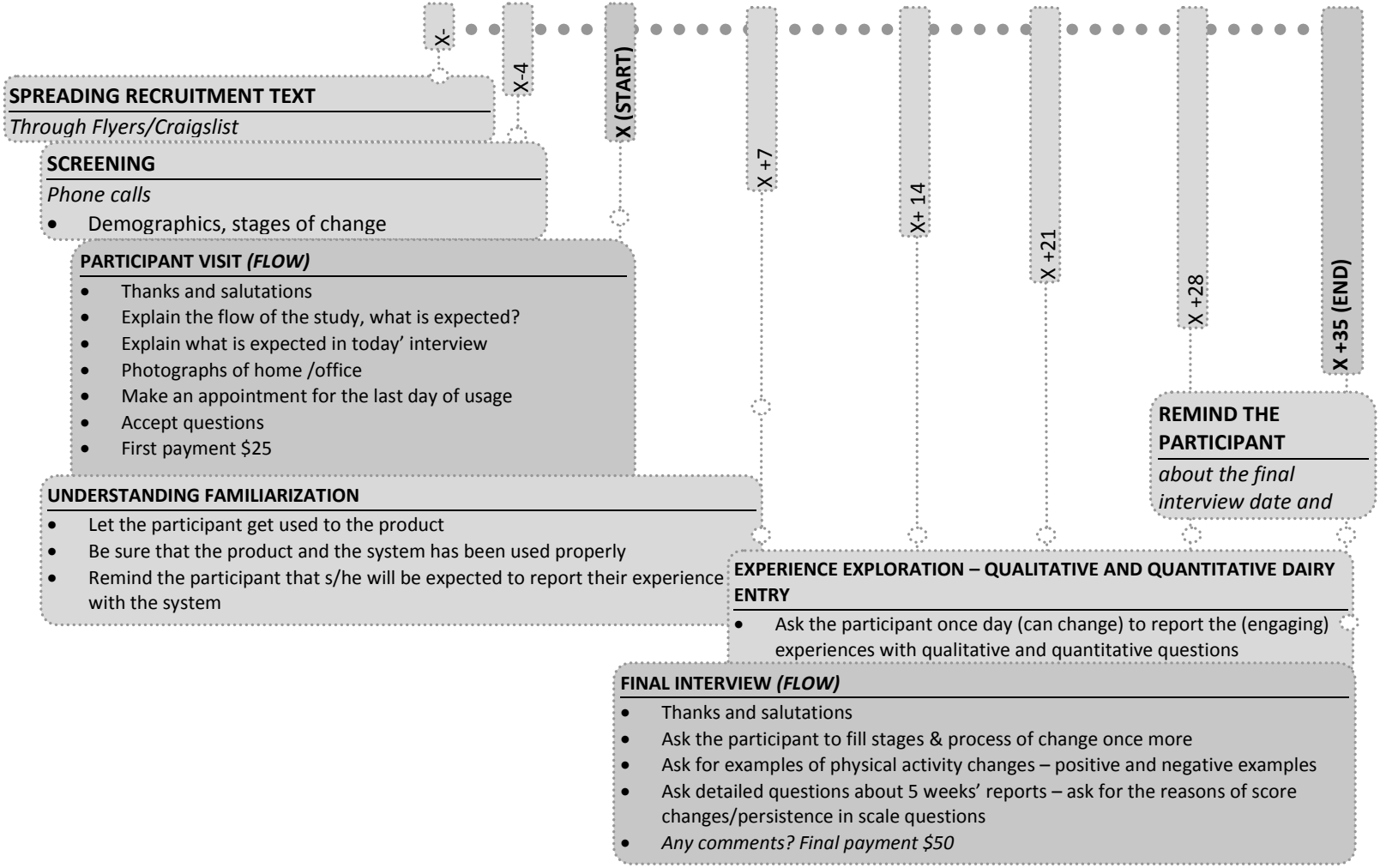

Figure 27. Flow of Study2

4.3.3. MEASUREMENT TOOLS

During the study, 2 scales were used to achieve (1) understanding the participants' physical activity behaviors, (2) understanding participants' experience, their system evaluations and explain their expectations.

Stages of Change Scale

Similar to the first study, to understand the physical activity levels of users, stages of change (Marcus & Forsyth, 2003) scales was used. As the original version of the scale is in English, full version of the scale was applied at the beginning and at the end of the usage process (Listed in Appendix B).

Experience and System Characteristics Evaluation Questionnaire

During the usage process, participants were sent an online survey link every day by using Qualtics Survey Software. They were asked to explain their experience in a similar sequence explained in Day Reconstruction Method (Kahneman et al., 2004). At the end of the survey, participants were asked to fill an 8-questions bi-polar questionnaire and rate their experience. The questions and reasons behind selecting questions are listed in Figure 28.

Table 10. Survey Questions

Negative Polar	***Positive Polar***	***References / Reasons***
Functions poorly	Functions well	**Previous study**, (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Fialho et al., 2009; Fogg, 2002; Maitland & Siek, 2009)
Does not make me feel good	Makes me feel good	**Previous study** (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Fialho et al., 2009)
Affects my social life negatively	Affects my social life positively	**Previous study,** (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Fialho et al., 2009; Fogg, 2002)
Is not aesthetically pleasing	Is aesthetically pleasing	**Previous study**, (Consolvo et al., 2006; Consolvo, McDonald, et al., 2009; Hassenzahl & Tractinsky, 2006)
Communicates with me poorly	Communicates with me well	**Previous study** (Ahtinen, Ramiah, et al., 2008; Consolvo, McDonald, et al., 2009)
Does not motivate me	Motivates me	**Previous study** (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Fialho et al., 2009; Fogg, 2002)
Does not keep me curious	Keeps me curious about the data	**Previous study** (Ahtinen, Ramiah, et al., 2008; Arteaga et al., 2010; Fialho et al., 2009)
Is poor in terms of interaction	Is rich in terms of interaction	**Previous study** (Ahtinen, Ramiah, et al., 2008; Consolvo, McDonald, et al., 2009; Fogg, 2002)

4.3.4. SELECTION OF PARTICIPANTS

The participants were recruited through email, phone or word of mouth. Similar to the previous study, all of the participants were unaware of presence of the system and all encountered the product for the first time. Voluntariness to be a participant was the first selection criteria. Potential participants sent email to the researchers. Unlike the previous study, one of the major selection criteria was having an IOS or Android mobile phone, as all the selected systems have an application. Participants were first contacted through email or phone to explain the aim of the study. They were asked their activity levels, and when they fit, an interview was scheduled. Within a pool of 89 people, 24 people were selected who fitted the selection criteria.

In total, 24 people (13 Female, 11 Male) participated in the study between the ages of 23-57 with a mean of M=33.58. The participants were assigned a system to be used for the following 5 weeks. In total 8 participants used each system (distribution of gender and ages are listed in Table 11)

Table 11. Distribution of Ages

Ages	*BM*	*FB*	*DB*	*Total*
20-29	4	1	5	3
30-39	1	5	2	4
40-49	1	2	1	4
50-60	2	0	0	2
	8	8	8	24

4.3.5. VENUE AND EQUIPMENT

The face to face interviews were conducted either at participants' offices or at the researcher's office. All the interviews were audio recorded and any identifying information was anonymyzed. IPhone 4S was used to record the interviews.

The phone interviews were not voice recorded, but the researcher took notes where required. The study did not require any other special setting. For the study, participant were also issued a generic email account (such as user1@gmail.com) to login the system which enabled the study to be controlled better.

4.3.6. SETTING – ABOUT PITTSBURGH

The study was conducted in Pittsburgh, PA, USA, a mid-size city in Western Pennsylvania. It was conducted between 22nd of February and 25th of May 2012. Although it was winter, it was unseasonably warm (was between 15^{0}C and 30^{0}C). Pittsburgh is a hilly city with limited public transportation. The study took place in the vicinity of two large universities, and the subject pool reflected this. In general, people affiliated with the university are concerned about their fitness, weight, and overall health.

4.3.7. COMPENSATION AND COSTS

Participants were compensated $25 for the initial interview, and $50 for five weeks of participation in the study. In any reason, if the participants decided to end the study before a 5-weeks period was over, they were not be compensated for incomplete 5-week periods.

4.4. DATA ANALYSIS PROCEDURE

This section covers the procedures applied during the analysis of the studies. Both in Study-1 and Study-2, participants gave valuable information on their experience and their expectations. As both first and second study cover qualitative and quantitative data, similar procedures were applied. The analysis procedures applied to answer the questions of studies are shown in Table 11.

4.4.1. QUALITATIVE ANALYSIS

In order to sustain richness of data and avoid the reductivity of data (Blomberg & Burrell, 2008; Diggins & Tolmie, 2003), qualitative data were analyzed in detail, by applying Grounded Theory (Strauss & Corbin, 1990) and Content Analysis (Krippendorff, 2004) . To analyze the qualitative data, each voice record was transcribed into Excel sheets. Then, *open coding* was conducted where system characteristics, qualities and participants' interactions, needs and expectations were identified (Strauss & Corbin, 1990). Each sentence of participants was combinations of several sentences; thus they were divided into meaningful utterances. To illustrate this, an example of one of the comments is given in Table 12.

As seen in the example one full comment of the participant was broken into 3 meaningful utterances and each utterance was counted as one comment. Being positive or negative was also specified during the coding process. Once finishing one example, multiple example coding sheets were created in both studies and the same coding process was applied both for Study1 and Study2.

Table 12. Example of Coding

	User Comment	*Main Code*	*Sub code*	*Implication*	*+ -*	*Talking about*
FB03	**Having that information**, the reason I **care about that information** is because especially since I do a lot of hiking around Front Park,	usability	usefulness	learning the steps taken in a defined route	+	Number of steps
FB03	I want to know **which routes I can take in a certain amount of time**	usability	usefulness	care about to learn the steps taken in a defined route	+	Places visited
FB03	Yeah. I would estimate that I have **increased my activity level** by something just short of probably around 80%.	motivation	achievement	increasing activity level by %80	+	Increase in activity

In both studies, having the codes and characteristics listed, a spreadsheet in Windows Excel was created for each interview. Each utterance of each participant was put into separate cells to code the comments. An implication cell was used to write what the participant implied in the comment. While talking about the product characteristics, participants also talked about their expectations from future products, or what they expected the system should have done. Therefore, expectations were also indicated during coding process and were separated from overall positive and negative comments.

During the coding process, to maintain the consistency, the first coding was done only by the interviewer. For assessing reliability of the coding (Krippendorff, 2004), in the first study thesis advisor went through the codes while in the second study, research advisor in US went through the codes and both advisors played active role in reaching an agreement upon codes. An iterative process was carried out until an agreement was reached.

In the second step of data coding, the concepts created by open coding were categorized (Strauss & Corbin, 1990) and these concepts referred to *system qualities and system characteristics*. Two glossaries of terms were created in both studies. These included (1) characteristics, which covered the product and system parts that participants talked about and (2) system qualities which covered the qualities that people mean. (Details of qualities are listed in related chapters). In the Study1, 4 main system characteristics and 12 system qualities were listed. In Study2, in total 6 main system qualities codes (aesthetics, behavior, emotion, interaction, technology, and usability) were defined in with 37 sub-codes in total. System characteristics were also listed similar to Study1; in total participants talked about 30 different system qualities in Study2 (All qualities are listed in Appendix H).

In Study1, using the exemplified analysis technique, 2472 utterances were listed. However, it was observed that some of the participants were more talkative and were talking more about some of the qualities. Then, it was decided that summing up all number of comments might distort data. In order to overcome this, percentages of mention times for each participant were calculated. The mean values of all qualities were then calculated to have the overall mention frequency of system quality. The same calculation procedure was applied as the participants of the Study2 were as much talkative as Study1 participants.

After the content analysis of Study2, system and user related comments of the participants were separated from each other to emphasize the system-related dimensions of engaging experience. Using the exemplified analysis technique, in total 6474 utterances was listed. Frequency of comments a participant made for each sub-codes were summed up for each participant as explained above.

4.4.2. QUANTITATIVE ANALYSIS

Statistical Analysis
For each study, the scores of each participant were put into excel sheets. Means and standard deviations were calculated, and related graphs were illustrated. In addition, relatively different visualization and data analysis techniques are used in each study.

***Study1*:** In Study1, with calculated means, two satisfaction-importance graphs were created to illustrate the state of the qualities and the status of each product characteristics. These graphs gave the overall idea about expectations of people from product characteristics.

***Study2**:* In Study2, to figure out the difference between FitBit and BodyMedia participants, graphs for each question was created to show the tendency of participants. In addition, to see whether there is any significant difference between the results to the daily reports of the participants One-Way Anova was run. All the questions of the questionnaire were also analyzed to figure out the correlations between the questions. To make the correlations appropriately, all "engaging" scores were transformed into Z-Scores as this question was asked to be rated in 5-score rating scale while final evaluation was on 7-score rating scale.

Comparisons
During the quantitative data analysis, comparisons were applied to figure out the changes between the before and after use for Stages of Change (first and second study) and Impressions (First study)

- In both studies, to indicate the Activity Stages of Participants, first and final activity stages were listed in tables, and the table was used to see the activity levels of each participant.
- For the first study, to represent the first and final impressions of participants, results were listed in a table at each participant level. At the end, one final graph showing the first and final impressions comparisons was created.

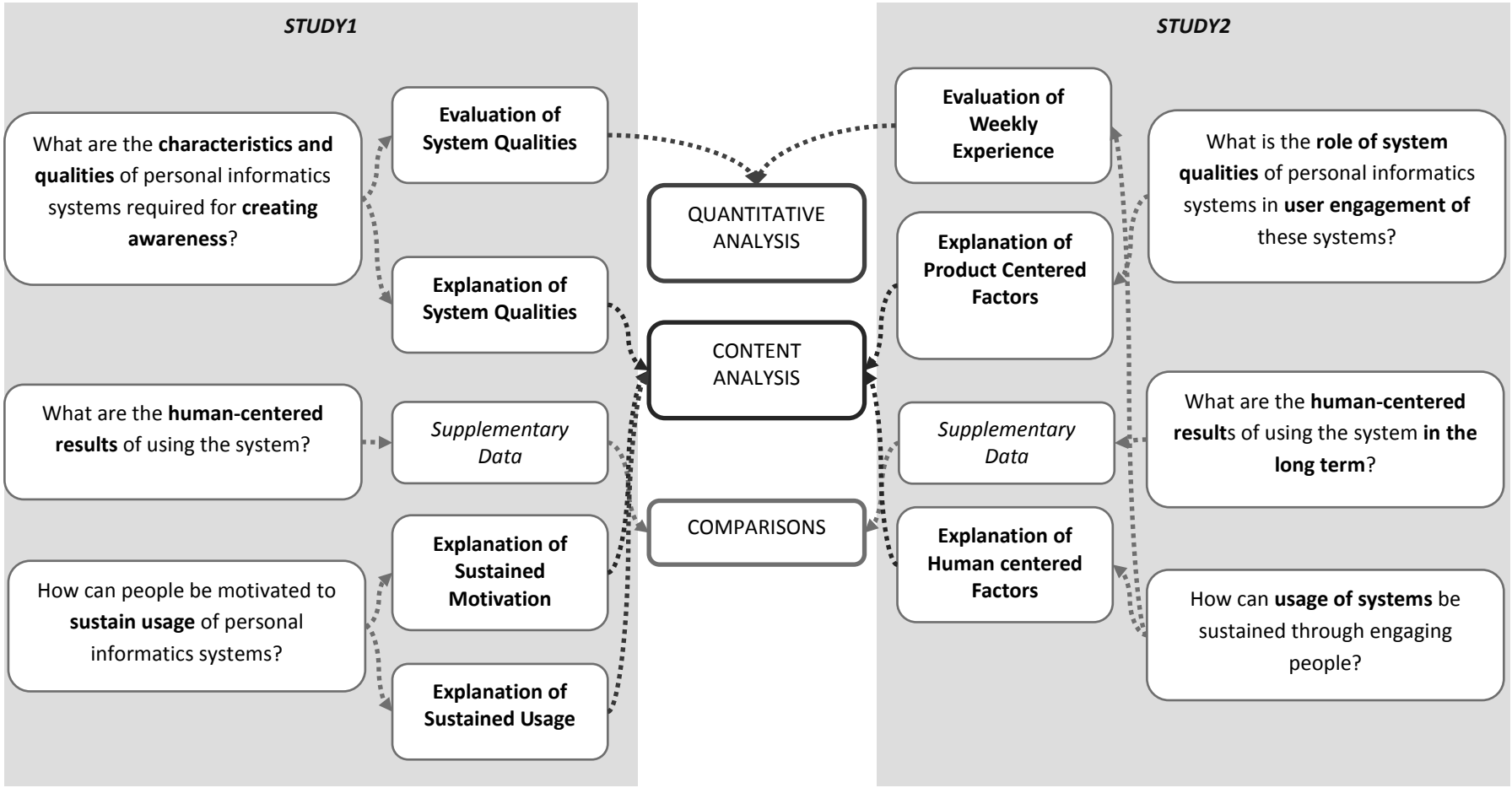

Figure 28. Data Analysis Methods Utilized to Answer Questions

CHAPTER 5

EXPLORATION OF EXPECTED CHARACTERISTICS OF PERSONAL INFORMATICS SYSTEMS

To revisit, data analysis will be presented to answer the main question of,

> What are the dimensions of early experience of personal informatics systems? (Experience related)

The main question will be answered through the sub-questions:

1. What are the characteristics and qualities of personal informatics systems required for creating awareness? *(System Related)* :
   This question will be answered in *explanation of system qualities and evaluation of weekly experience* sections.
2. What are the human-centered results of using the system? *(User related)*
   This question will be answered in *first and final evaluations and stages of change* sections.
3. How can people be motivated to sustain usage of personal informatics systems? *(Time related)*
   This question will be answered in *sustained motivation and sustained usage* sections.

Results of the study will be presented under relevant each sub question. At the end, the main question will be answered by blending the answers of the sub-questions (Figure 29).

5.1. QUESTION1: WHAT ARE THE CHARACTERISTICS AND QUALITIES OF PERSONAL INFORMATICS SYSTEMS REQUIRED FOR CREATING AWARENESS?

This sub question will be answered through the following two sections; *explanation of system qualities and evaluation of system qualitie*s. Explanation of system qualities section covers relations between qualities and characteristics and hierarchy of qualities, and evaluation of system qualities section covers results of mean values of product and system related characteristics (Figure 29).

5.1.1. EXPLANATION OF SYSTEM QUALITIES

Participants were asked to talk about the reasons of their evaluation of product qualities during final interviews. Mention frequencies of each system qualities varies (Table 13) with changing emphasis on different system characteristics. Therefore, each quality will be explored with respect to the hierarchy of them (Table 13). The details of data coding (i.e. code usage and related system characteristic) as well as example narratives are listed in Appendix H. Note that all quotations were translated from Turkish to English by the researcher.

The explanations below will be the summaries of the findings and implications of participant responses in relation to the table shown in Appendix H (Data Analysis Details of Study1).

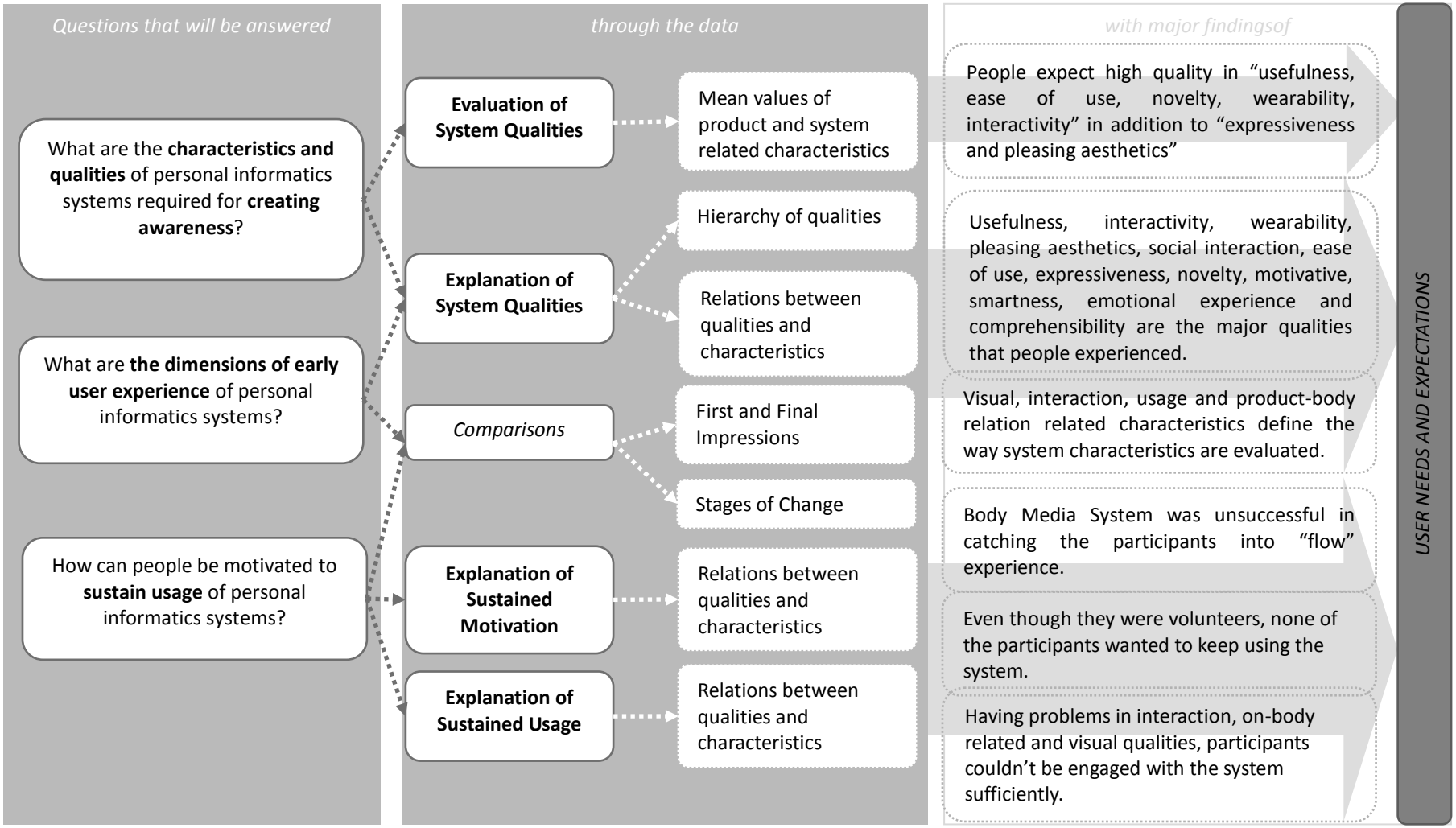

Figure 29. Overview of Study 1: Questions and Major Findings

Table 13. Hierarchy of System Qualities in Reference to Mention Percentages

	VISUAL	*INTERACTION*	*USAGE*	*BODY RELATION*	*TOTAL*
usefulness	3.61	4.84	6.46	3.44	18.36
interactivity	0.35	12.39	0.36	0.27	13.37
wearability	1.59	0.00	3.29	6.56	11.44
pleasing aesthetics	10.31	0.40	0.41	0.08	11.20
social interaction	8.78	0.04	0.28	0.33	9.44
ease of use	1.14	0.65	3.01	2.75	7.54
expressiveness	6.81	0.00	0.41	0.03	7.25
novelty	4.30	1.98	0.13	0.02	6.43
motivative	0.26	3.73	0.82	0.07	4.89
smartness	0.35	3.57	0.21	0.04	4.17
emotional experience	0.97	1.67	0.33	0.23	3.20
comprehensibility	0.00	2.43	0.18	0.10	2.71
Total	38.46	31.70	15.90	13.94	100.00

Usefulness

Participants explained usefulness in relation to other system qualities (i.e., interactivity, aesthetically pleasing and wearability). For instance, personal data were only available through online activity manager for those who did not have a smartphone, which resulted in negative comments of those participants. One of the participants stated that, as she thought that it was a burden to connect the device to the computer, she checked her data only once. This example contradicts with the intended usage of the system, indicating that people expect **instant connectivity.**

All of the participants were positive about the usefulness of the data shown in the online system. The abilities of the device, such as counting steps, calculating calories burned and storing data throughout the day were all stated be useful by all of the participants, and all of them appreciated the graphs shown in online system. However, 5 of the participants (User 03, 04, 05, 10, 18) stated that even though the device is collecting a lot of data about the user, it does not **analyze the data**, and thus does not **make any suggestions** in relation to users' data. Two of these participants defined a "**personal coach**", which is defined like a personal assistant which should give advice to the user, by looking at user's data. Another expectation from the device was that it could be able to collect all kinds of personal data, such as pulse and blood sugar. This was defined as a way to get as much benefit as possible. In summary, people expect these devices to be able to collect all kinds of personal data, analyze it and make suggestions throughout the day.

Three male participants had doubts about the accuracy of the device (User 02, 05 and 14), and they tested the accuracy of it by doing "*ridiculous*" activities, such as jumping or throwing something. Interestingly, those realized that the device was more or less accurate, and this led increase in positive comments of those participants.

Thinking of the abilities of the device, size of it was stated to be too big to be carried. As its size is stated to be *huge* (User 04, 08, 11, 13, User15), it was stated to restrict the usefulness of the device. Size also indirectly affects feeling of its presence. Even though participants would like to forget about it, because of its size, it both catches attention of other people (see social experience) and the user. In addition, people expect to use more **comfortable devices** to forget its presence. On the other hand, some of the participants purposefully expected not to forget its presence, in order to remember the focus of using it. Some of the participants expected the device to combine product abilities with multimedia characteristics. For instance, the device should give the opportunity to upload music so that people can listen while doing physical activity.

In summary, these results show that, even though people believe that the main functions of the system are very useful, other drawbacks of the system made the usefulness of the system questionable. People expect the **data to be accessed easily** and the **system to be connected in any condition**, but it was not possible in the current system. It can also be argued that usefulness of the current system is not satisfactory at all; thus participants expected wide variety of system qualities to be supplied by the system.

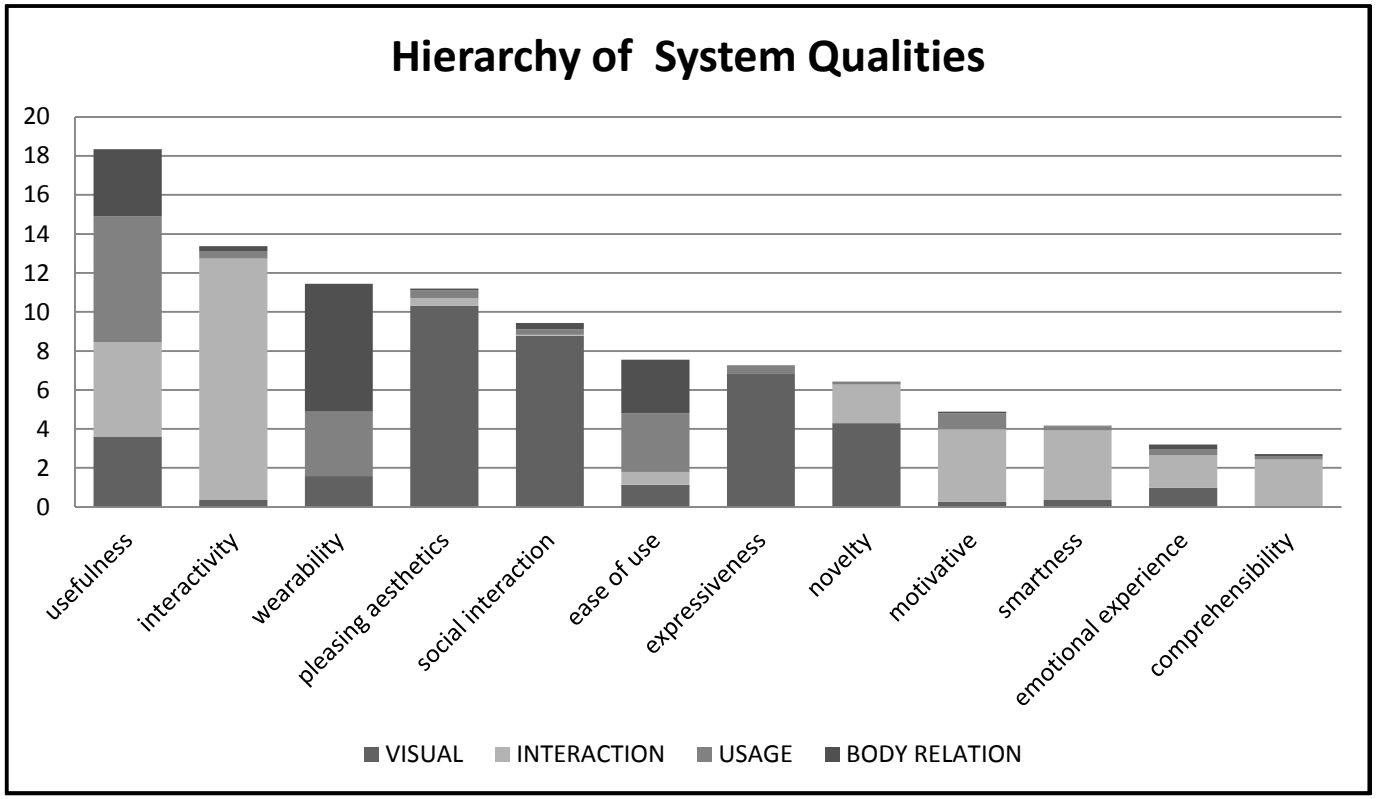

Figure 30. Hierarchy of System Qualities in reference to Mention Percentages

Interactivity

Main concern of the participants about interactivity of the system, was the way of interaction with their personal data. Most of the participants were satisfied with the interaction of the online system, and visual presentation of personal data. They were mostly positive about the quality of the data interacted through online system, as it gives the ability to investigate details of the data. It has different visualizations which enabled the participants to make implications easily. However, they were dissatisfied with the interaction with the device, caused by several reasons.

First, device is not able to **show data instantly**; rather it required to be connected to the online system. The **simplicity in reaching and interpreting data** through online system were expected to be reached whenever people were curious about it. Second, the system requires **regular connectivity**, such as having internet connection to sync data; however people may not be able to have constant internet connection. Third, it is users' responsibility to connect the device to the computer to check data; however, people expect the system to offer better interaction media to reach it. Thus, **connectivity** arouse as a major expectation of the participants. Reaching data instantly affects both usefulness and interactivity positively. As an example, two (User 02 and 14) participants were able to reach their data with the IPhone application and those stated that it was "extremely easy and useful" to sync the device with the phone and see personal data instantly. These show that, even though the system seems to solve connectivity problem by offering different media, **instant data** was only available for smartphone users, and thus other people expect it too. As stated, **getting direct and instant feedback** has special importance for participants, they wanted to know immediately how many calories they burn or how many steps they take, but they couldn't achieve this, because of disabilities of the system. These were stated to be major motivation breakers.

From the interviews, it is learned that people relate usage and interaction to each other. In terms of personal informatics systems, the main concern of people is reaching data when they desire. Success in doing this, a personal informatics system can convince people that it is interactive, useful and helpful.

Wearability

Participants wanted to carry the device on different parts of the body and expected it to be **compatible with the body**. Size of the device caused this expectation, as it was defined as "too big to be carried" (see pleasing aesthetics), which also caused disturbance during sleep. Five (User 04, 05, 08, 13, 18) of the participants indicated that, form of the device sometimes influenced their sleep quality. Four of the participants also participants stated that they felt pain on the arm (User 04, User 10, User17, User18), and had to take it off, when they woke up in the middle of their sleep. In relation to these, most of the participants expected the system to offer **flexibility and comfort in mobility**.

The device, by its nature, was only carried on the upper arm of people, and it has to be strapped around the arm; thus it has to touch people's skin. However, the way it is worn is stated to have affected participants negatively as they made myriad number of negative comments about the mobility of the device. They expected the device to be suitable for carrying on different parts of the body.

In relation to the previous examples, wearability of the device also affected the pleasing aesthetics and social interaction evaluations (see also those). Another major negative comment about the device was that it wasn't making its presence forgettable and not suitable to be carried on the arm. As it catches other people's eyes because of the way it is worn, wearability was associated with "**invisibility in form and use**". It was visible to other people and was catching attention. This led the participants to remember that they are wearing the device all the time which shows how wearability of the device can affect social interaction.

These indicate that form of wearability should not contradict with **flexibility of usage**. People should have the control over wearability of the device, as most of the participants didn't want the device to be worn on upper part of the arm which makes the device totally visible or predictable.

Pleasing Aesthetics

Participants wanted the device to be suitable for personal taste with its size and design. It was also expected that the size of the device should not catch other people's eyes and disturb its user. This affected the participants in two ways: It affected wearability of the device negatively, and it attracted attention of other people. This was indicated to create negative implications for the participants. Likewise, some of the participants tried to hide the device with mid-sleeve t-shirts. It was even harder to hide it as the study was held in summer. Male participants were more successful in hiding it; however female participants were unable to do that, and were disturbed by the attention of others. As an expectation, female participants wanted the device to offer flexibility in mobility in order to be able to hide it whenever they want.

Participants expected the device to be aesthetically pleasing which affects the expressive qualities of the device. As an expectation related to the size, participants wanted the device to look like other wearable products, such as wrist watches in order to be able to hide it better. This way, the device would not also be eye-catcher.

As can be implied, pleasing aesthetics is closely related to wearability. If the portable part of the system is in **convenient size** and gives the **flexibility in mobility**, then people will have positive impressions about it. Pleasing aesthetics is also closely related to social interaction and expressiveness (see related parts for more details) as visual characteristics of the device give information about the user of it.

Social Interaction

All female participants talked about the **visibility of the device** as they were annoyed by the questions of people. It created undesirable conversation with others and visibility of the device was indicated to be the reason of staring eyes. Participants were led to think that people mistook them as if they were seriously ill. That's why they expected it to be less obvious and less intruding.

As part of the social experience, participants were expected to talk about sharing data with others through online system; however, only a few of the participants did. Three of them didn't even think about sharing data with others as there found no value in doing it. Two of them didn't want to share, as they didn't want other people that they are using the device, and trying to lose weight.

Participants were concerned about size, **portability and visibility** of the device which affect habits and lifestyle of people. People have to think about what they wear in order not to catch eyes which can cause serious problems of usage over time. However, the aim of those kind of systems should be creating awareness by being part of people's life without changing their lifestyle. In this case, people's attention moves from being motivated by its functions to being frustrated by its aesthetics.

Ease of use

While talking about its usage, participants stated difficulties in usage. These are also related to **appropriateness of size and weight**. Ease of use is related to the availability of freedom of movements. While most of the participants were positive about it, the size and location of the device was stated to restrict doing some of the activities. Those were also stated to be inconvenient for long term usage and not easy to use every day. It also created sliding problems as it was mentioned to slide down when the user sweats. When the strap is tightened, it creates marks of the metal sensors. In addition, the device covers a large area on the arm, and during summer days, that area is not exposed to sun, resulting in a big "device mark" on the arm. As a precaution of **visibility**, some of the participants had to shift the **location of the device** which caused some of the participants to take extra effort to straighten the location of the device.

Participants also didn't want to wear the device off and plug it in the computer (i.e User 03, 04, 05, 10, 11, 18, 20). This was defined as the major distractor of **flawless interaction**. Instead, they expected more practical way of **data realization**. In addition, some of participants stated that they wanted to enter the food they eat, but they couldn't find specific Turkish food in the system which made the usefulness of the system questionable.

Once again, it is implied that system qualities are tightly connected to each other, in ease of use case, people expect the system to have good wearability, interactivity and smartness features. These also strengthen the idea that a personal informatics system cannot be designed by splitting it into pieces, like website, device and application; rather it should be designed in total.

Expressiveness
Nearly all participants stated that the device looks like a "blood pressure measuring device", and it does not have a **visual language** that is designed specifically for this device. Still, four of the participants (User02, 07, 10, 14) stated that it is not vital, as the device roughly is related to health. As it catches attention of others, this visual language resulted in an idea that "owner of the device has a serious illness". Participants also associated visual language of the device with medical products and this has been the major issue of **expressive** qualities. These associations resulted from the visual similarity between the device and other medical devices.

Because of the **size of the device**, it was stated to be not appropriate for business life. For four of the participants, visual language of the device is neutral and appropriate for usage of wide variety of people. Visual analogies strongly affect perception of expressive qualities and visual similarities evoke unexpected social status, while it actually should be associated with a positive change.

Novelty
Participants associated novelty with good interaction qualities. There was a general understanding that novel products shouldn't need other media to check data instantly. It was also associated with systems' ability to catch up with recent technological developments. Even though the idea of measuring self was new for participants, when novelty effect wore off (in this study, it was 3-4 days) the product technology was no longer appreciated. **Static system** qualities, such as seeing the same kind of data each day, made users get bored of the system. In addition to its functional deficiencies, form of the device also affected perceptions of novelty. It was stated to look like old fashioned products. Thus, it is important for these systems to maintain novelty to help people to keep using the system.

Motivative
In particular, **ability of the device**, such as counting steps and showing the number of calories burned, was defined a positive motivator. By looking at these data, participants were able to associate the data with their daily activities. This resulted in positive evaluation of motivative qualities, as the quality of collected data impressed participants. On the other hand, it was criticized that the system did not go beyond simply showing data. It was expected to give **personalized prompts** for each user, such as making suggestions in relation to daily activities (i.e, User 03, 04, 05, 10, 11, 18,) or cheering up the user to do more physical activity (i.e, User 10, 11, 12, 13, 15). That way, people would get more fun of using it, and be more motivated.

Another criticism about motivation was that, in relation to the facts explained in interactivity, participants believed that **instant feedback** is vital for motivation. Only in that way, they would engage with the system, and feel the motivative effect of it. In the current system, the data started to repeat after a while, as nothing much change in participants' daily life during the weekdays. However, instant feedback and **case-specific solutions** stated to reinforce motivation (i.e. User08). These actually imply that people expect the interaction of systems change in order to **adapt** changing user needs so as to motivate them.

It is also motivative when the device gives **incentive feedback** or **fun messages** in order the user to get engaged with the system, otherwise the feedback could not create flow of usage. Even though participants did not mention motivative qualities of the system as much as other qualities, they are inherited from system' own objective. It is also apparent that most of the system qualities should enrich motivative ones; people would like to feel engaged with the system so as to get the most benefit from it.

Smartness
Expectedly, smartness and motivative qualities of the system has mutual effect on each other. Even though most of the participants admitted that the device has smart features, other system qualities can diminish smartness. In relation to motivation, system was expected to be smart enough to **make analysis** (i.e. User 04, 05, 08, 09, 11, 14, and 18) of users' daily activity and **make suggestions**

accordingly (i.e, User 20). Participants expected good data quality as the device was expected to measure all body functions, including blood sugar and weight of the user. Those expectations also include demands of very specific suggestions, such as suggestions for eating habits. In relation to the above expectations, the most important part of those suggestions was "**personalized" feedback** which might also be related to people's illness or special conditions.

Smartness, like motivative, is acquired by system' objectives. Naturally, it is a technological outcome of designing such systems. However, the highest level of smartness is relevant to users' imaginations. Once people start using it, their needs to change when the novelty wears off; then people start to expect different kinds of data, most importantly "personalized data". Therefore, these systems should amaze its users by **adapting itself** to their expectations.

Emotional Experience

The number of comments on emotional experience is lower, which actually resulted from the focus of participants: rather than focusing on the emotions aroused from using it, they focused on the usage and aesthetics of the system. Still, participants expected the system to offer **fun experiences** to get engaged with the system and prolong the usage of the system. This was expected through good interactions (which have already discussed in interactivity section) but still the system can be implied to lack in offering good emotional experience.

Comprehensibility

Comprehensibility of the system wasn't a problem of most of the participants, therefore it wasn't mentioned intensively, still comments of two of the participants makes it clear that **presentation of data** in native language of the user makes the data more **understandable**. As the study was conducted in Turkey, native language of all the participants was Turkish; however, the system language was English. Even though most of the participants were able to understand English, two of them stated (User 12 and 15) that they had difficulties in understanding the website. This led them to define the system as less useful and comprehensible for them.

Understanding whether the device senses the user indicated as a minor comprehensibility problem. The only way to understand is its audio feedback when it is first worn on the arm. However, some of the participants had problems in understanding whether it was working or not. Those participants also had to check the device a couple of times to make sure that it was working. In addition, the quality of feedback that the system gives, when it starts running reinforces the interactivity of the system. Even though it is not a general problem, these indicate that **continuous and visible feedback** is expected in terms of interactivity.

5.1.2. EVALUATION OF SYSTEM QUALITIES

To discuss the results of evaluation of system qualities, the data were split into two; product and system characteristics and those are presented in importance-satisfactory graphs in each section (the mean values and standard deviations are presented in Appendix I). It should be noted that the most critical area of these graphs is high importance-low satisfaction area, as the characteristics that fall into this area need extra effort to be developed in future products. Therefore, the results will be discussed regardless of "satisfaction" ratings.

In formulation of importance-satisfactory graphs, the lowest mean value of both importance and satisfaction questions were defined. By defining the mid-point between the highest possible score (in this case 7) and the lowest score given, the mid-line of the graph was drawn. Both importance and satisfaction mid-lines divide the graph into four, namely- high/low satisfaction/importance. In relation to those, each item falls into one area depending on the importance and satisfaction mean values of that item.

The mean values of 53 of the items of the questionnaire are higher than M=4.00 (medium of the scale) and standard deviation of the items gets higher than 1.00 for most of the characteristics related to pleasing aesthetics, expressiveness, wearability and novelty. Difference in standard deviation indicates the disagreement between the participants, in terms of importance of some of the items: some of the participants rated those characteristics higher than other participants. The

interview results discussed in the previous section can be turned to clarify why participants rated the characteristics differently. Product related characteristics

In the satisfaction-importance graph of product characteristics (Figure 31), there are four types of characteristics: visual, usage, interaction and body-relation. Each characteristic will be discussed in relation to the level of importance.

Visual Characteristics

Mostly, the characteristics that are related to aesthetics and expressiveness of the product were less important. Participants did not demand these products to have *fanciful, expensive and impressive appearance or appealing colors*. In addition, having highly recognizable *technological or electronic product language* is not expected. *Gender differences* in visual qualities is not considered to be vital, as well as not having "*serious-product appearance*".

On the other hand, having *aesthetical and modern appearance, elegant appearance, non-ordinary design, good quality, delicate appearance, and technological appearance* were highly expected. Particularly, having *modern, good quality, elegant and aesthetical appearance*s have close mean values which are higher than the mean values of other visual characteristics. These show that, people expect these products to have "simple and unique" forms without having extreme visual characteristics (such as being fanciful).

Usage Related Characteristics

For participants, usage related characteristics were crucial. "*Offering freedom of movement, having a design that doesn't restrict freedom of movement, being convenient to use while in the motion, being durable, having an ergonomic design, being suitable for daily usage*" are all usage-related characteristics that participants were highly important for people. These characteristics have also strong relations with on-body related characteristics and it is apparent that for participants the product did not restrict their movements extensively.

There is only one characteristic that fall into low importance area of the graph, which is *easy to hold*. Mostly, the device was already on participants' arm, and holding the product is only important when it is not worn. Thus this characteristic is not listed within the important usage related characteristics.

Body-Relation Characteristics

There is only one characteristic that falls into low satisfaction area of the graph which is *being not apparent to the eye while not being used*. Participants thought that the product is actually not used when it is not on the body; therefore this characteristic is not important at all. Similar to "easy to hold" characteristic, this one was not considered as a vital product related characteristic.

The characteristics that are related to wearability of the product fall into the most important product characteristics area. For instance, all of the participants agreed that *being harmless to the body* is the most important characteristic of the product (M=7.00). In relation, the most important 3 characteristics, *having manageable weight, being in harmony with the body, being easy to be carried out are* also listed in high importance area. It is also apparent that size and appearance related characteristics are the ones that participants paid importance. These characteristics include *size, harmony with the body, having flexible shape, accessory like appearance and use and versatile carrying and wearing*. This is a critical result, as those can be improved with redesign of visual characteristics of the device.

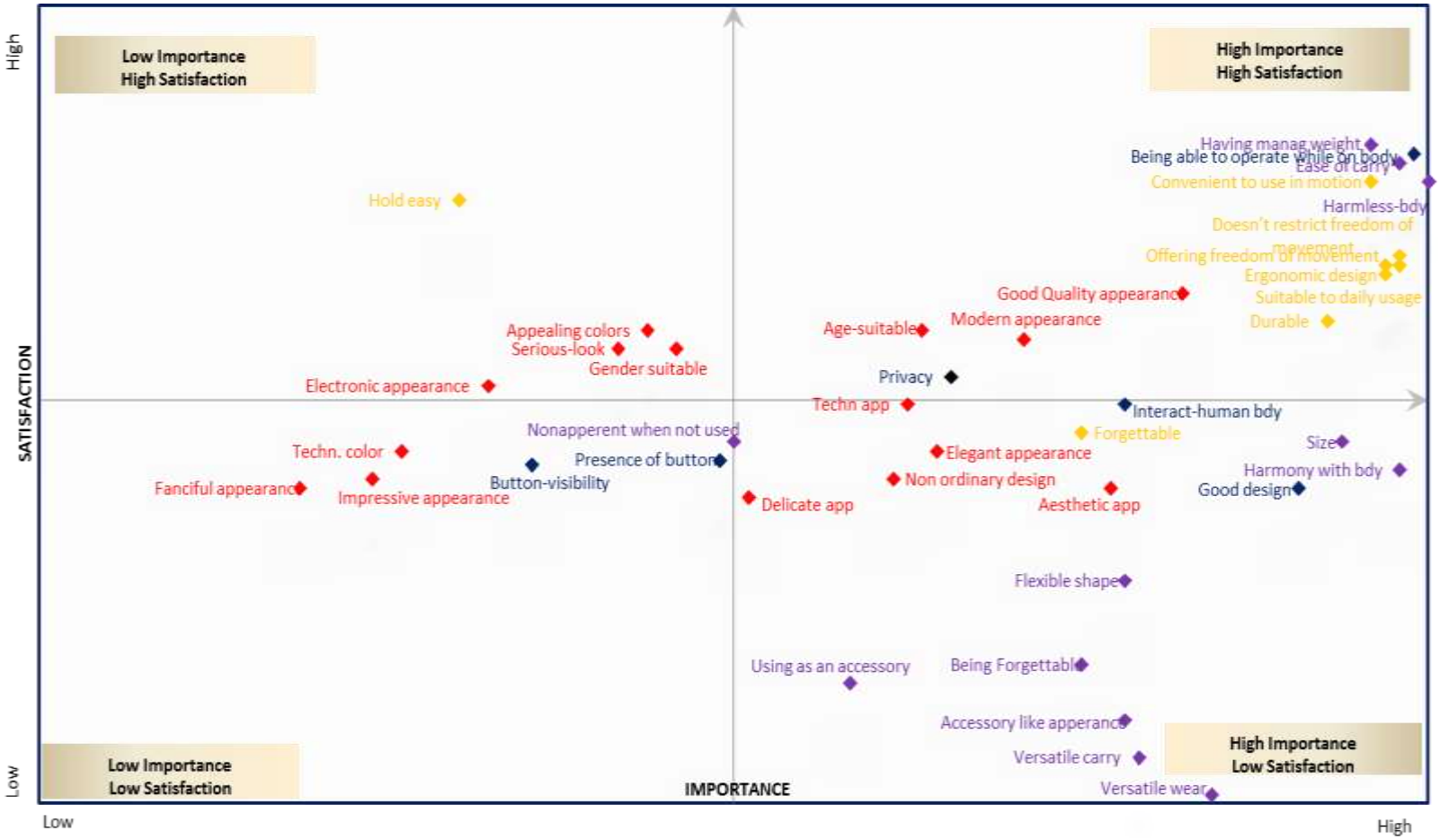

Figure 31. Importance-Satisfaction Graph of Product Characteristics
(Red indicates Visual; Orange indicates Usage; Purple indicates On-Body Related Characteristics and Dark Blue indicates Interaction)

Interaction Related Characteristics

There are two characteristics that have low importance within interaction related characteristics: *presence of buttons and visibility of buttons when being used*. The product has only one button and only participants who had IPhone could be able to use that button, to sync the data with the phone. Therefore, other participants did not think that "buttons" are important and should be used when interacting with the product.

Most of the interaction related characteristics are listed in the next section, as interaction with the product itself was very limited. The only important product related characteristic that is related to the device is *being able to operate while attached to human body* and participants were positive about its abilities.

Implications of the Results

Product related characteristics evaluations show that;

- The **visual characteristics** of the device affect satisfaction of more than one single product quality, thus corroboration can be observed with the data presented in the previous section. The size of the product should concur with the usefulness and wearability of it. Participants expect less attractive or impressive, but more functional products. The product should still have modern, elegant and pleasing appearance.
- In terms of **usage related qualities**, participants were mostly satisfied with the basic functions of the product, as was also discussed in explanation of system qualities section.
- In relation to **body-product related characteristics**, the way the device is carried should not impose a certain type of carrying, but should assure the flexibility in mobility. The freedom of user movements should be yielded with the form of the device.
- **Interactivity with the device** is not required through elements of the device, but rather is considered as interaction with the whole system (see next section)

All these support the idea that the qualities of the device should be designed by thinking of the experience of the user holistically.

System Related Characteristics

The number of system characteristics is limited compared to the product related ones. Figure 32 shows these which include only usage and interaction related characteristics.

Usage Related Characteristics

There is only one usage related characteristic that fall into low importance area of the graph, which is *having reminding features*. The system actually offered a reminding feature, but the participants either didn't notice or use it. Therefore, it wasn't listed in the important system characteristics.

Within the usage related system characteristics, participants paid importance to *being practical, giving usable information and ease to use, offering creative solutions, having multifunction and multimedia features*.

Interaction Related Characteristics

There is only one interaction related characteristic that fall into low importance area of the graph, which is *having touch operated interaction*. The system didn't offer an interface to interact with the data, thus participants didn't think that "touch-operated interaction" is vital. However, from the previous findings, it is apparent that they want to interact with the system through several media, but it is not only "touch-operated interface".

For participants, interaction related characteristics of the system were crucial, especially *usable information, having fun interactions and having screen for use, having accessible interface, presenting understandable interactions and feedbacks* which are strongly related to how people reach the personal data, hold importance. This may be resulted from the appreciation of the technology, as

participants rated novelty related characteristics highly important; in relation the characteristics "*good technology use, having advanced/cutting edge technology, being innovative and having different technology*" are all in high importance area.
Considering that all participants encountered the system for the first time, appreciating the technology of it can be anticipated. Thus, thinking that the system has an online activity manager and the data can be reached through that, participants were actually appreciating the technology, which enabled measuring and showing the data. Still, it should be revisited here that, in their interview data, participants expected the system to show data instantly; which actually was indicated in dissatisfaction of "*screen for use*" characteristic.

Implications of the Results

System related characteristics evaluations show that;

- Participants were mostly satisfied with the system, thus what it should be ensured in the future systems.
- The technology of the system was appreciated; it enables several functions and interaction of the system; thus technology should appeal interaction with the system by making the elements of the system easy to interact.
- The interaction with the system should be fun, without forcing the user to perform it unexpectedly.
- The data should be visible to the user and be interacted whenever the user desires. Thus, appropriate ways to interact with the personal data should be facilitated.

Again, these support the idea that designing the system holistically will ensure the flawless interaction and usage of the system.

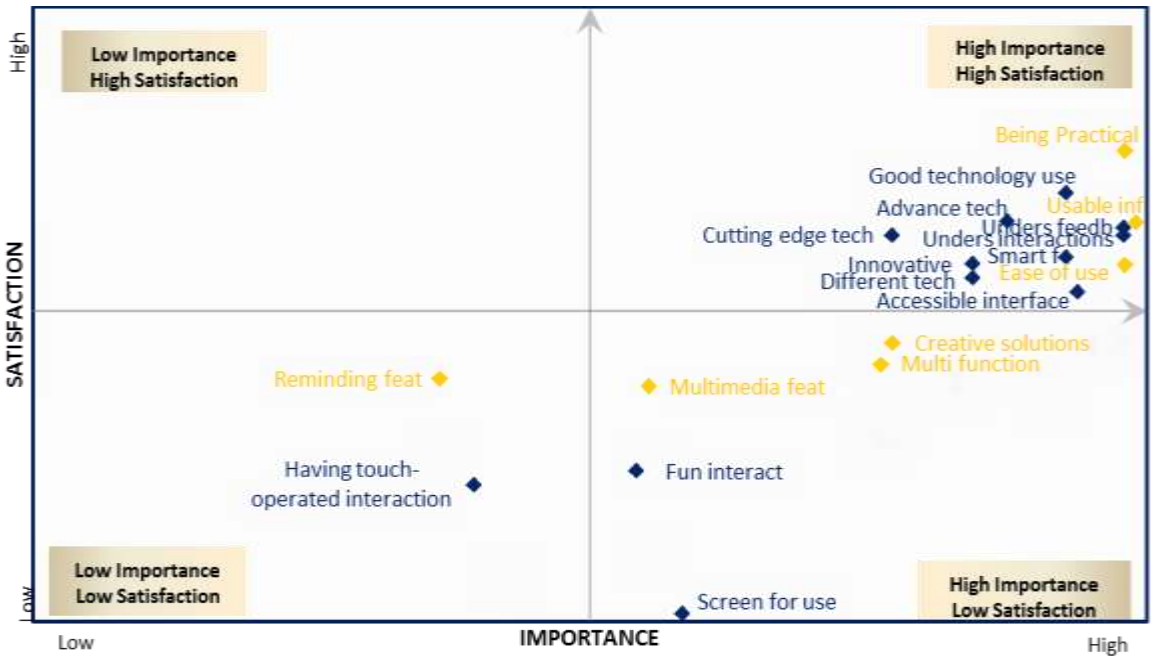

Figure 32. Importance-Satisfaction Graph of System Characteristics
(Light Blue indicates Usage and Orange indicates Interaction)

5.2.1. OVERALL EVALUATION

The qualities were also grouped into 7 in relation to what people related as *usefulness, ease of use, novelty, wearability, interactivity, expressiveness and pleasing aesthetics* (Figure 33).

People pay importance to *usefulness, ease of use and novelty,* and they were satisfied with the system in that respect. On the other hand, in terms of the other important qualities *wearability and*

interactivity, the system did not satisfy participants, the reasons of this result have already been discussed. It can also be observed that, visual qualities were paid less importance compared to function-related ones; and thus *expressiveness and pleasing aesthetics* fall into low importance area. Still, product satisfies expression needs up to a point, but it is not good enough to be satisfying pleasing aesthetics. It is also observable that mean values of both expressiveness and pleasing aesthetics are close to the border of high importance area. Thus, it cannot be concluded that visual qualities are not important at all.

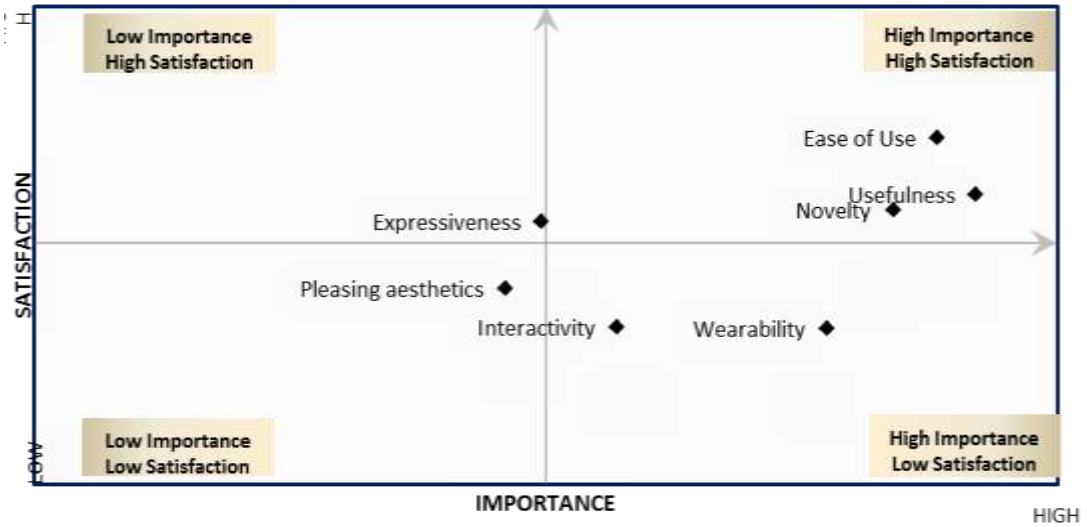

Figure 33. Satisfaction-Importance Graph of All Qualities

The results presented in explanation of system qualities and evaluation of system qualities sections show the problems that participants encountered, and indicate what they expect from these systems. All in all, participants indicated wearability, interactivity and pleasing aesthetics problems which affect their motivation to both become active and keep using the system.

5.2. QUESTION2: WHAT ARE THE HUMAN-CENTERED RESULTS OF USING THE SYSTEM?

This sub question will be answered through the following first and final impressions and stages of changes sections. First and final impressions section covers participants' initial and final evaluation of the system with non-verbal pictorial scale and stage of change section covers participant' first and final physical activity levels (Figure 29).

5.2.1. FIRST AND FINAL IMPRESSIONS

The impression graphs that were shown to the participants at the beginning and at the end of the study are analyzed to clarify the differences between emotions. First and final impressions data show (Figure 34) that participants' impressions both at the beginning and at the end of the study were positive towards the system with slight differences.

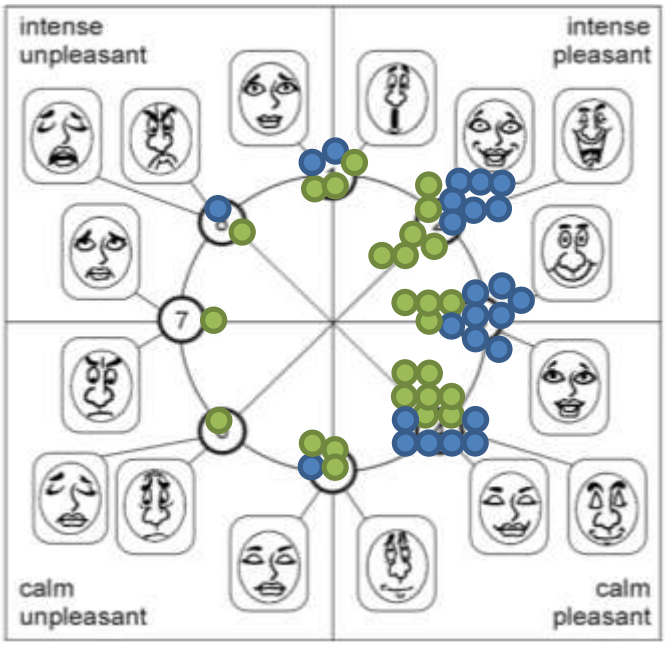

Figure 34. First and Final Impressions of Participants
(Blue indicates first, Green indicates final impressions)

While at the beginning the reports were more at intense pleasant side of the graph, at the end they were more calm-pleasant side; even two of the participants were unpleasant about the system. Those can also be explained with the results of "explanation and evaluation of system qualities". Participants were volunteers at the beginning and were slightly more positive towards the system while at the end they were less positive, as the system came up to be less satisfactory in terms of the major system qualities as they thought it would be.

5.2.2. STAGES OF CHANGE

The Stages of Change scales that were filled by the participants at the beginning and at the end of the study are analyzed to understand the differences in activity behaviors. The results Stages of Change Scale showed that activity behaviors of 5 participants were changed (Table 14). However, as the usage period was not long enough to understand the reasons of behavior change, it cannot be argued that this change absolutely had been caused by the system usage. Still, the number of participants who stated to have changed their activity level are impressive.

Within the participants, 17 of 20 aimed to learn about self and 4 aimed to lose weight. The reasons for the change are interesting. For instance, User01 stated that she was trying to lose weight, and this system pushed her to make a little more activities. On the other hand, User04 stated that he tried to take a couple more steps to see what changes in his life. Similar to User01, User07 was also trying to lose weight, and she stated that she became aware of her activities and also the number of calories in foods (such as waffles). She also stated that she lost 1.5kilograms in 1 week. User 14 is also another example of people who are trying to lose weight. His situation is actually different than other 2 examples, because he was under control of a dietitian and doctor. He was also able to see his activity data through his phone. He stated that, seeing data motivated him a lot, that's why he started to become more active. Final behavior change example is User20. He was a college student, but he didn't have any problem with his weight; but he said he only became active so as to recompense the system: in other words he only became active as he was using device. Other participants didn't think that the system could help them more than learning about their activity levels. Behavior change was not the aim of the study, but to understand the system qualities and dimensions of experience that would lead to behavior change. Therefore, creating awareness in the short term has been a positive outcome of this research.

Table 14. Changes in Stages of Activities in Detail

AgeRange	*User*	*First Stage*	*Final Stage*	*Gender*	*Initial Goal*
30-40	U01	2	3	Female	(1) Lose weight (2) Learn about self
20-30	U02	3	3	Male	(1) Learn about self
20-30	U03	4	4	Female	(1) Learn about self
30-40	U04	2	3	Female	(1) Lose weight (2) Learn about self
20-30	U05	2	2	Male	(1) Learn about self
20-30	U06	5	5	Male	(1) Learn about self
30-40	U07	3	4	Female	(1) Learn about self (2) Lose weight
30-40	U08	2	2	Female	(1) Learn about self
20-30	U09	1	1	Female	(1) Learn about self
40-55	U10	4	4	Female	(1) Learn about self
20-30	U11	2	2	Male	(1) Learn about self
40-55	U12	5	5	Female	(1) Learn about self (2) Keep activity level
40-55	U13	4	4	Female	(1) Learn about self
30-40	U14	3	4	Male	(1) Lose weight
40-55	U15	5	5	Male	(1) Learn about self (2) Keep activity level
20-30	U16	2	2	Male	(1) Learn about self
20-30	U17	2	2	Female	(1) Learn about self
30-40	U18	2	2	Male	(1) Learn about self
40-55	U19	3	3	Male	(1) Learn about self
20-30	U20	2	3	Male	(1) Learn about self

5.3. QUESTION3: HOW CAN PEOPLE BE MOTIVATED TO SUSTAIN USAGE OF PERSONAL INFORMATICS SYSTEMS?

The following sustained motivation and sustained usage sections will be utilized to answer this question. These sections cover responses to the questions of whether they were motivated by the system and whether they would like to keep using the system (Figure 29).

5.3.1. SUSTAINED MOTIVATION

When asked at the end of the final interview, whether using the system had motivated them or not, 9 of the participants stated that the system had, at least limited number of, positive effects on **regulating their daily routines.** However, as the system lacked the qualities they expected, 11 of them indicated that they were not motivated at all. Even, the participants, who stated indications of motivation, expected the system to be changed, in order them to be much more motivated. Thus, all participants require the system to be changed.

As can be seen in Figure 35, 21.07% of the comments were on the qualities that are related to the usefulness of the system. 13.64% were on awareness, 7.44% were on wearability, and 5.79 of them were on interactivity. This means that, sustained motivation is closely related to how useful the system is, how it makes people aware of their activities, how suitable the device is for carrying all the time and how interactive the system is.

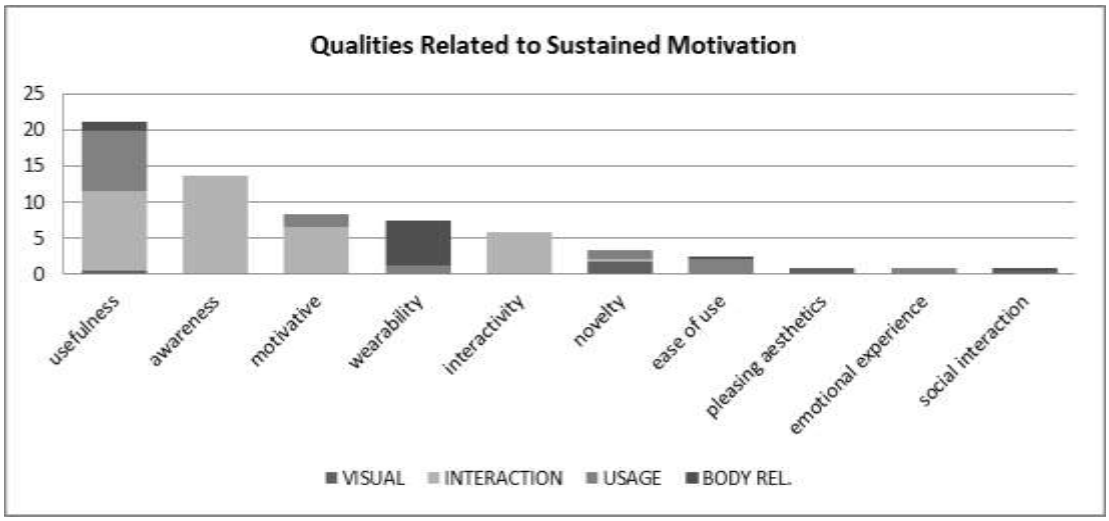

Figure 35. Qualities Related to Motivation

While talking about the effect of usefulness of the system to their motivation, participants actually emphasized on the "usefulness of the data". **Data quality**, such as detailed activity and calorie reports, had positive effect on motivation of the participants. For instance, one of the participants stated that realizing that she was sedentary; she walked around the house to increase her activity. In relation to this, participants made positive comments about usefulness of the system in increasing their awareness as a motivational factor. The system stated to have increased their awareness, and the more awareness they gained, the more they became curious. Again the quality of data was effective in gaining awareness and increasing their motivation.

> *"Minute-specific data was very impressive. For instance, I played soccer last week, graphs had up and downs. I mean the number of steps I took at the beginning, in the middle and at the end of the match changes a lot; and it showed me the differences. I could be able to see the number of steps I took when I went to a shopping mall. Showing the details minute-by-minute is more impressive than showing the total number of steps." (User02)*

Wearability of the device indirectly affects motivation. For instance, while one of the participants believed that the system supports people's motivation, the **portability** issues of the device is a negative influential of motivations, and should be redesigned. As already stated in motivative qualities section, it was revealed that the system has little effect on motivation as the system was not designed to motivate the user: it only collects information and the user can only get it if wondered. In other words, the system is passive in terms of interaction, usefulness and thus motivation.

> *"The system can be awesome if it could say, "hey! You took this many steps. So this means this many calories and this many kilometers". I prefer it could analyze and combine some of the data, so that I can understand it better."(U07)*

Using such as system was valued for its usefulness, which users believed resulted in awareness and thus motivation. However, users reported that the system caused **social stigma** because of its wearability issues. Moreover, lack of expected interactivity qualities dilute perception of usefulness, getting the most benefit from the system and thus voluntariness to keep using the system.

5.3.2. SUSTAINED USAGE

When asked at the end of the final interview, whether they would like to keep using the system, 14 of the participants stated that they didn't want to keep using the system. 6 of them were neutral about the system, but all admitted that in order them to keep using the system, the system should be revised in relation to their expectations. In total, 53.85% of the comments were on the qualities that are related to

the usefulness of the system. 15.94% were on motivation, 7.14% were on wearability, and 5.49 of them were on social interaction (Figure 36). Participants who will to keep using the system mentioned mostly about the useful characteristics of the system, such as helping the user to lose weight and showing useful data.

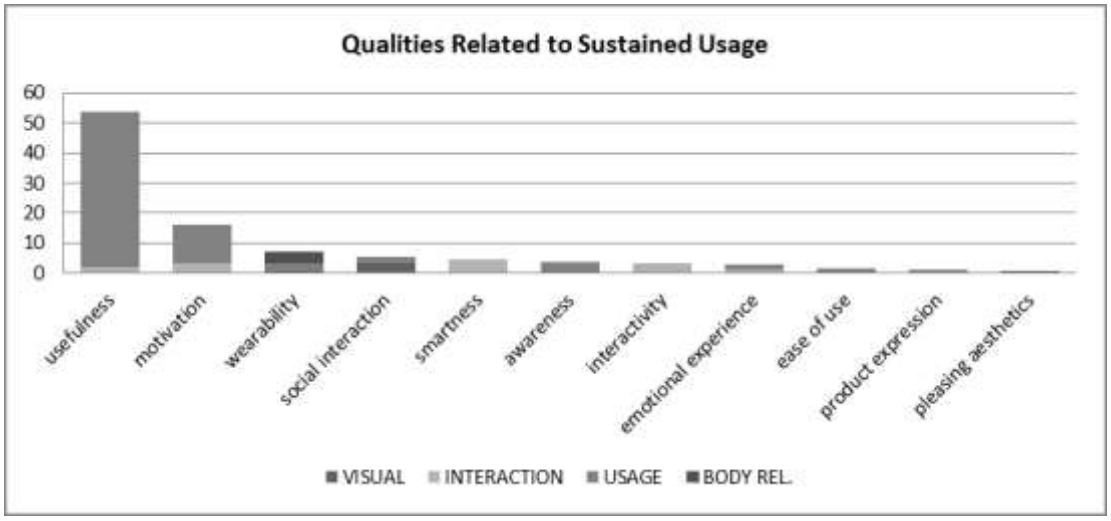

Figure 36. Qualities Related to Sustained Usage

The reasons for not willing to use the system were mainly related to the long term usage. Participants stated that the system qualities were **not engaging** in order users to keep using it. For instance, most of the participants expected the system to **suggest activities to change their daily routine** and **motivate the user to be active time to time**, but without interrupting the daily routine. However, the system was only measuring the activity level and this information was only known when the user wants to know. Moreover, the system was problematic in terms of the interaction (as stated in interactivity section) and was one of the reasons of unwillingness.

> *"After a while, using it becomes routine, because I learn the data after I use it. However, if it helped me when I do physical activity, I'd use it. Because, then it can speak to me, can say something like "you're doing well" or like "your heart is pumping this much blood not" or "you're burning fat now", "keep going, if you do this, you'll burn more." I'd like to see or hear those kinds of comments. (User06)*

Getting the data through only online system, users expected the system to offer more easy and versatile **ways of reaching and engaging the data**. Additionally, visual qualities of the device were also stated to be the reason of unwillingness (see aesthetically pleasing). The product seemed to be huge to be carried on the arm. Therefore, users stated that it should be **small in size or even invisible** in order not to catch attention and thus not creating constrained conversations. In addition to its size problem, carrying the device only at upper arm was indicated to be another reason to unwillingness to keep using the device, as it was restricting the user in action. It was expected to offer **various modes of carrying** in order user to will to use.

Another reason of unwillingness to use the system was that after a while, novelty wears off and system tells nothing new for the user. This led users to feel burden about using the system and get bored of using it.

> *"After a while, wearing the device and using the system turn me off. For instance, it can show my improvement, but doesn't. In addition, it would be more helpful if it were interactive. I forgot to sync data and I didn't have much time to do that. Then I*

would want to use it over time, but I don't want to use it with current features. All right, I have learned how many steps I take every day, nothing changes." (User17)

These indicate that people expect a personal informatics system to have qualities that they would like to keep using. They do not want to have interaction and visual problems, so that the system can keep them engaged with the system: otherwise, usage becomes a burden and results in boredom. In keeping people engaged, all listed system qualities should somehow integrated into the system to create sustained behavior awareness and behavior change over time.

5.4. DISCUSSIONS

This study pointed out the key points in understanding the system qualities and early user experience that would lead to behavior change. There are three major findings:

- Relations between the product qualities reveal that, in early experience of personal informatics systems, people care about functional and visual qualities equally.
- Early experience of personal informatics systems is shaped by people's initial goals, satisfaction of their initial needs and their further expectations.
- People should be kept evoked during the usage, in order to sustain motivation and usage, and they should be engaged with the system usage.

The study also showed potential points to be further studied to keep people engaged with the system. This is also required to have a holistic framework of making people keep benefit the system.

5.4.1. RELATIONS BETWEEN PRODUCT QUALITIES

The qualitative analysis technique applied, enabled understanding the relations between system qualities and characteristics and people's expectations from the system. In previous sections, system qualities (i.e usefulness, interactivity, aesthetically pleasing) were discussed in relation to four system characteristics (visual, interaction, usage and body-product related). Incorporating the relations between those will lead to learn the dynamics of early experience of these systems. To do this, all percentages of comments presented in 5.1 were used to create the graph of relations. For this, "NodeXL (Smith et al., 2010) network graphs creating software" was used and the outcome graph is aimed to understand the emphasis of relations and to figure out the potentials of further research. In this graph, the sizes of the circles indicate the strength of the quality or characteristics in comparison to others. Besides, the strength of the lines indicates the strength of the relation between the quality and the characteristic. The distance between the circles does not have any significant meaning.

The results show that product and system characteristics cannot be isolated from each other but should be designed as a whole. The qualities related to *visual and interaction* characteristics are the most outstanding ones which indicate that both hedonic and utilitarian qualities equally shape the early experience of these systems.

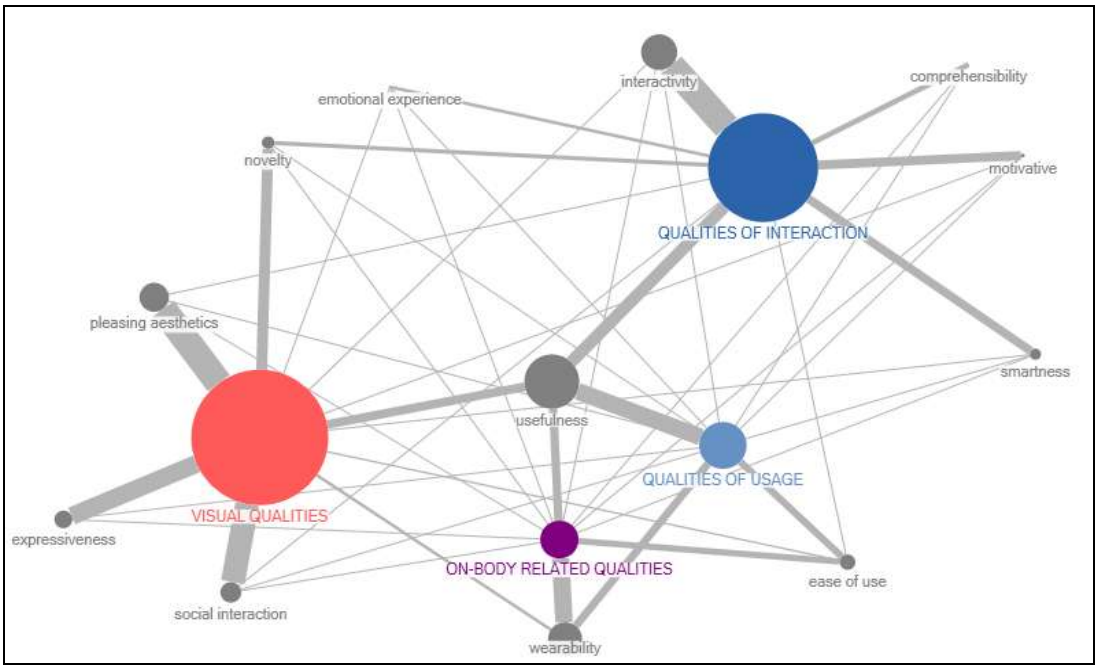

Figure 37. Relations Between Product Qualities in Early Experience

The figure illustrates that:

- *Visual characteristics* highly affect all qualities; aesthetically pleasing, product expression, social interaction, novelty, usefulness and wearability. Interestingly, they are the major influential of other system qualities.

- *Interaction characteristics*, naturally, affect perceptions of interactivity most. In addition, it affects usefulness, smartness, motivation and comprehensibility. As stated in 5.1, 5.3.1 and 5.3.2 mention frequency of interaction related characteristics are the second highest one. It is because, indicated interactivity problems shape people's expectations about interactivity. As a major expectation, people await these systems to undertake exhilarating interactions, such as poking the user with prompting messages so as to make them take extra more steps to be active during the day.

- Characteristics related to *usage* mostly affect utilitarian qualities like usefulness, ease of use, wearability and interactivity. People appreciate basic functions of the, such as counting steps, calories burned, as the system is not one of those which people encounter before. Still, in relation to the interaction characteristics, people's expectations on interactivity of the system are highly relevant to ease of use and wearability; people expect these systems to be easy to interact and have versatile ways of carrying.

- The less mentioned characteristics are the *on-body related* ones, and these are related to wearability, ease of use and usefulness more strongly than others. The satisfactory-importance graph (Figure 33) also shows that people were dissatisfied with pleasing aesthetics and wearability of the system, which are closely related to on-body related characteristics of the device.

5.4.2. EARLY EXPERIENCE OF PERSONAL INFORMATICS SYSTEMS

To explain the early experience of personal informatics systems, from the evidences of the results of the study, the experience can be divided into 3: *before use, during use and after initial experience*. The following discussions are also illustrated

Figure 38 to show the model of early experience.

Willingness: As discussed in Stages of Change section, people's initial goals affect the success of the system. People who have a concrete goal or an expectation (ie. knowing about self or losing weight) to use such a system, would get more benefit, in comparison to people who don't. When people start using the system with initial goals, they will be more willing to keep using the system. Initial personal goals and motivations can also be regarded as the indicators of willingness to initial use. Also, having positive first impression is likely to affect the initial evaluation of system positively.

Initial Benefits: In the early days of usage, people explore the possibilities of the system intensively, especially in terms of its functions. In this period, all product characteristics play vital role in exploration, as all product qualities and characteristics have strong relations with each other.

Visual, usage, interaction and body-relation qualities of the system have mutual effects on experience, and some of the product qualities have strong relations with more than one characteristic. For instance, usefulness of the system is strongly related with usage, body relation, interaction and visual qualities of the system, and if designers will improve usefulness of the system, they should address to the perception of these three characteristics. The same situation applies for all other characteristics.

Sustained Usage*:* Sustainability of usage should be assured, by working on the experience of people in relation to the system characteristics as people tend to leave the system usage if they feel that the system has not effect on them. Once they learn about themselves, the data becomes a routine. Unless system gives user-specific feedback, it becomes a burden for the user to keep using the system. On the other hand, creating long term awareness is required to keep people performing a desired behavior. In terms of personal informatics system, this can be supplied by keeping people *engaged with the system* more, as people in the study lost their enthusiasm after 1-week of usage. Thus, finding ways to keep people be engaged with the system can maintain continuity of usage.

It was observed that participants mentioned about *usefulness, interactivity, wearability and pleasing aesthetics* more than other qualities. These qualities give idea about what people expect from personal informatics systems during early days of usage: These systems should be *useful*, especially in terms of data, ensure good *interactivity* with the data, diversify *wearability* of the potential portable device and have good *aesthetical* characteristics to satisfy users. While ensuring these, it should be noted as the major issue that, once people start getting results of their activities, their expectations from the system in terms of usage and interaction changes, because after a while, they become aware of their daily routine.

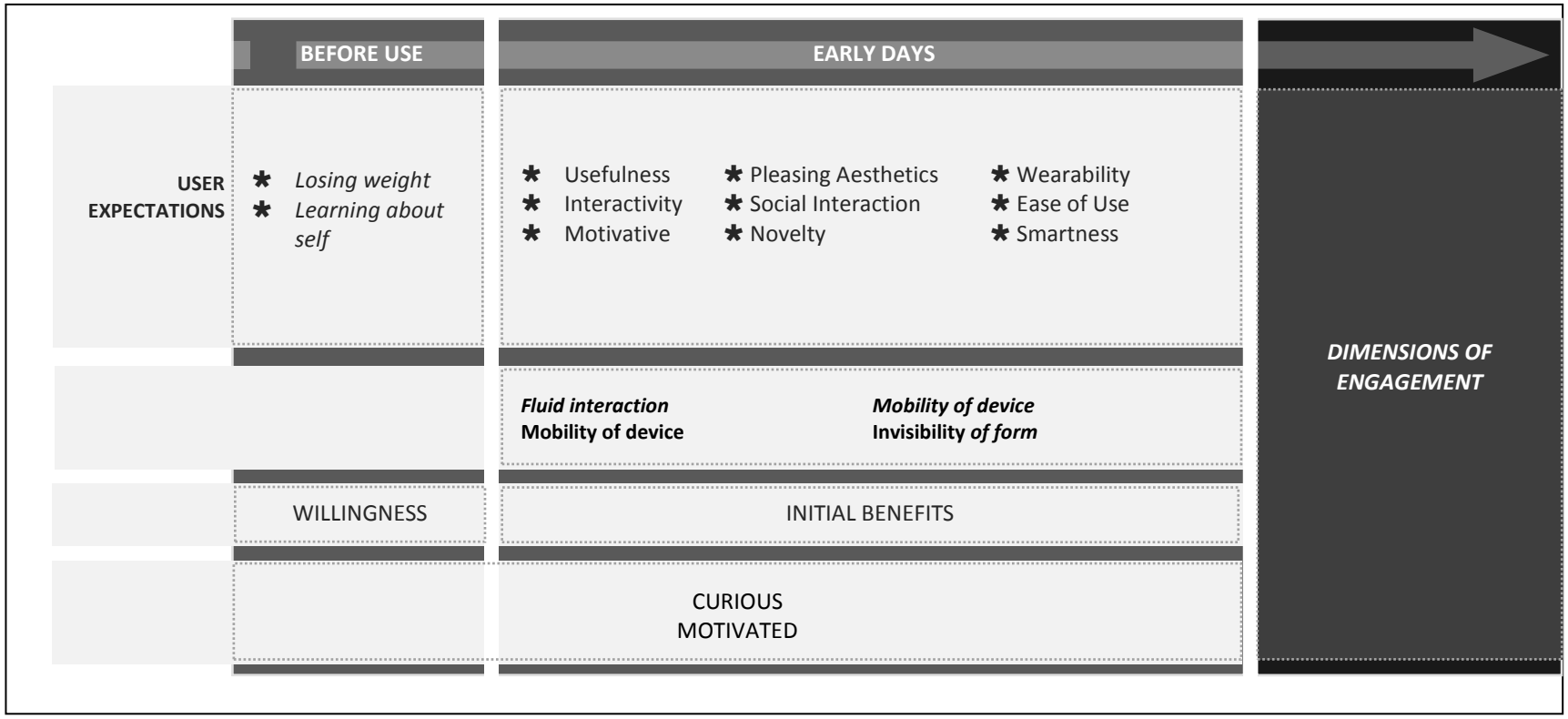

Figure 38. Model of Expected Qualities of Personal Informatics Systems

5.4.3. MOTIVATING PEOPLE TO BE ACTIVE AND SUSTAIN THEIR USAGE

It was emerged that people didn't feel enthusiasm to keep using the Body Media System. They wished to keep using the system only when the system is redesigned. The lack of enthusiasm is the indicator of interruption of awareness and motivation. In relation, when people stop using the system, it is likely that they revert to their early behavior. Thus discovering system qualities to certify motivation to create awareness would give cues about the ways to make people enthusiastic in using the system. This study contributes to design of personal informatics systems with listed findings:

Usefulness of the system reinforces sustainability of usage: It is fundamental that people need to get the most benefit from these systems. Most of these systems have similar functions, but the ways these functions are presented should fascinate the user to pull them into usage process. This fascination can be yielded with adaptability of the system qualities to the user needs, (such as flexibility in wearability of device or fluid interaction with the data) through which users can also suspended from boredom or anxiety in usage and be led to flow in experience (Csikszentmihalyi, 1990).

Quality of feedback boosts motivation: The feedback that the system gives on changes in physical activity should present motivating messages for the users. In addition, this feedback should be instantaneous in order to sustain motivation throughout the usage. Problems in interacting with the system leads to lack of maximum benefit from the system.

Good visual qualities ensure the motivation to use: It was proved that visual characteristics of the device are important as they should coincide with users' taste, and should not catch attention of other people. Visual qualities also have tight connections with wearability of the device: on-body related characteristics should be diversified to give people opportunity to be carried in different ways.

Make everything easy for people to make them familiar with the system: It was discovered that ease of interaction with the system and ease of carrying of the portable device are indirect underpinnings of increase in motivation. When the system withstands what the user wants to get from the system, it is obsolete that users' interest will be lost. This will lead to abandonment of the system. The major way of keeping people aware of their physical activity is keeping people use the system for long time. The tenets listed above show that, people should be engaged with the system with several system functions. However, Body Media system was not successful in doing this. The listed system characteristics (visual, interaction, product-body relation and usage) were not satisfactory enough to orient the users into "flow in experience". Even though the study has evidences in finding the ways to sustain usage and motivation for longitudinal awareness, the role of system qualities of personal informatics systems in user engagement of these systems requires better understanding.

5.5. CONCLUSION

The study revealed that people are open to use and accept personal informatics systems. Still, unwillingness to keep using the system was the major common point of the participants although all of them were volunteer and enthusiastic to be a participant. In addition to the previously listed ones, participants had concerns which can further affect the usage of these systems:

- They did not want to carry the product for long time, as the experience with the system became routine over time. They learn, more or less, the average number of steps they take or calories they burn in an average day. However, this information does not inspire them to be active.
- The device needed to be connected to a computer to sync and see the data, which became a burden for the participants. Instead, it is expected for the device to give instant feedback.
- While most of the participants supposed that the product useful for activity tracking, they no longer wanted to carry the product at all the times. This unwillingness will lead to lack in realization of the effect of long term use of the product. These factors collectively point out how it might be difficult to understand the use of personal informatics tools over time.

As already learned, motivation is an important factor in behavior change and designers should ensure it. It was realized that engaging users with the system over time can motivate people to keep using a product, leading to further motivation for its use. Further research on engaging user experience of personal informatics tools is required to construct knowledge about how they can motivate people and ensure awareness. It is also required to comprehend (1) whether lack of enthusiasm to further use the system is case specific or this is a common situation for different types of personal informatics systems and (2) whether this situation is time specific or this is a common situation for long term usage.

For all the listed reasons, characteristics of different personal informatics systems will be examined in the next chapter to suggest how designers could assure user engagement. Study2 will guide designers to be conscious about the required product characteristics that will provide engaging experience. Finding the dimensions of engaging experience of personal informatics systems to sustain motivation and usage over time and drawing the model of *user engagement of personal informatics systems* will be main the contribution of this dissertation to the field.

CHAPTER 6

EXPLORATION OF USER ENGAGEMENT IN PERSONAL INFORMATICS SYSTEMS

To revisit, the collected data (as explained in Chapter4) was analyzed to answer the following main question:

What are the dimensions of user engagement to sustain usage of these systems? (Experience related)

This main question will be answered through the sub-questions:

1. What is the role of system qualities of personal informatics systems in user engagement of these systems? *(System Related)*
   This question will be answered through explanation of product centered factors and evaluation of weekly experience.

2. What are the human-centered results of using the system in the long term? (*User related)*
   This question will be answered through explanation of human centered factors and stages of change.

3. How does people's evaluations of the system change in long term usage? *(Time related)*
   This question will be answered through *evaluation of weekly experience.*

Similar to the previous study, results of the study will be given under each sub question. At the end, the main question will be answered in the discussion section (Figure 39)

In Study2, it was observed that the quality of daily reports of FitBit and Body Media participants were better than Daily Burn participants. Moreover, while nearly all of FitBit and Body Media users seemed to use the device and system every day, only half of the Daily Burn users utilized the system. It is because, FitBit and Body Media users did not have to log in the system, but could see data through phone or device display. However, Daily Burn users had to log in every single thing they eat or do. On the other hand, some of the Daily Burn users only logged their food more frequently than their physical activity, as they were free to use the system as they wanted. Because of these Daily Burn data were excluded from the analysis and will be utilized when needed.

6.1. QUESTION 1: WHAT IS THE ROLE OF SYSTEM QUALITIES IN USER ENGAGEMENT?

This sub question will be answered through the following section named *product centered factors*. It covers the hierarchy of qualities and explanation of each quality in relation to responses of FitBit (FB) and Body Media (BM) participants during final interviews.

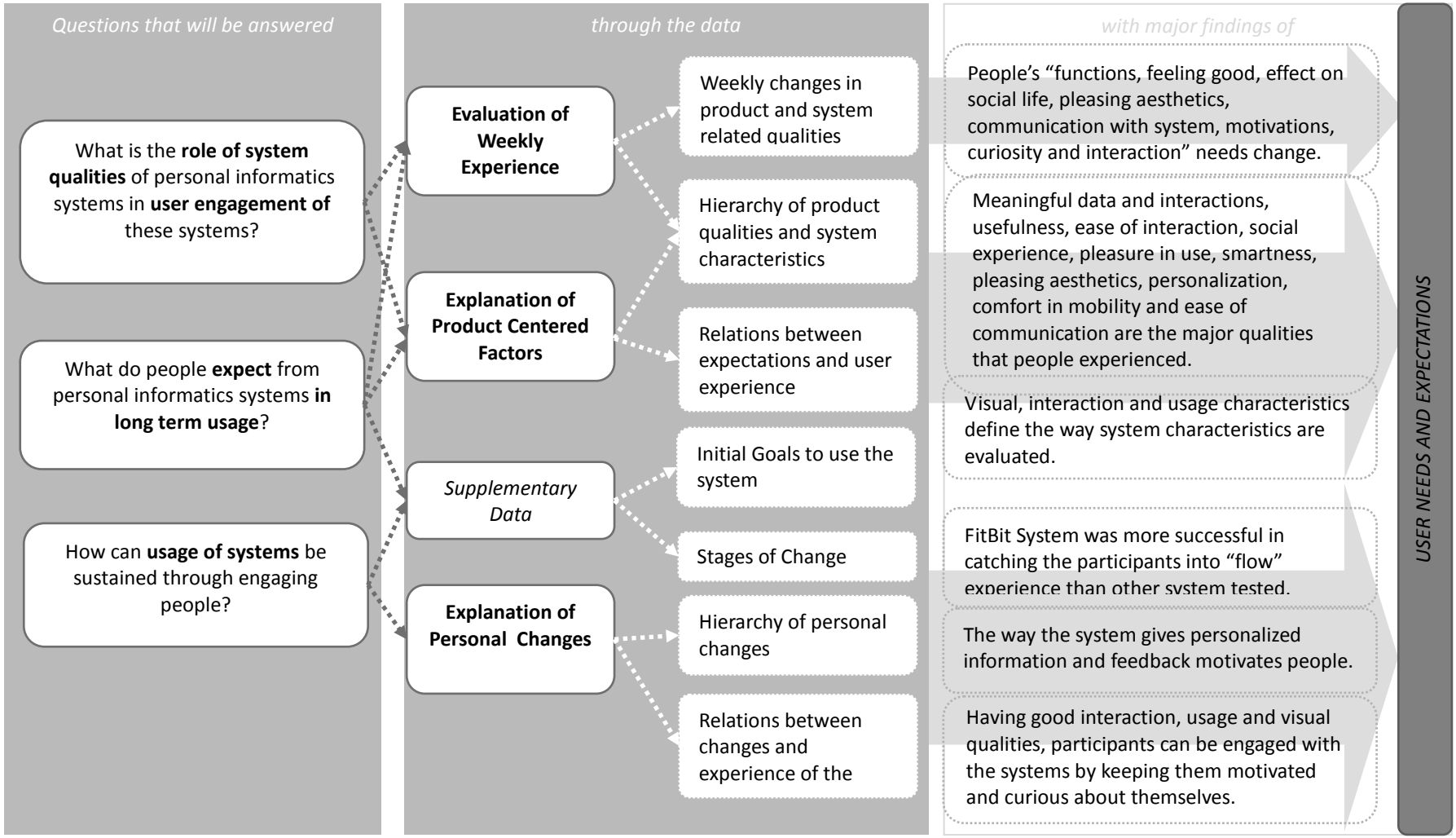

Figure 39. Overview of Study 2: Questions and Major Findings

6.1.1. PRODUCT CENTERED FACTORS

As explained, participants were asked to talk about the reasons of weekly evaluation of system qualities during the interviews at the end of the 5 weeks. The details of data coding (i.e. Code usage) are listed (Appendix J) as well as example narratives. The mention frequency of system qualities varies with changing emphasis on different system characteristics (Figure 40 and Table 15).Therefore, each quality will be explored with respect to the hierarchy of them.

Meaningful data/ Interactions

Both BM and FB participants talked about the quality of data and interaction with the data more than other qualities (Table 15). However, FB users made more positive comments than BM participants and BM participants made more negative comments than FB participants. Not surprisingly, BM participants expected the system to be changed in better way to satisfy user needs.

Both FB and BM users stated that the systems **give meaningful** data: users are able to figure out the number of calories they burn steps they take, their activity levels, and their sleep qualities However, BM participants were concerned about the type of information they see on their mobile phones (application). The problem is different from the Study1; they have the ability to sync device with the mobile phone but once they sync it, they could only see the numbers, but not the **visualization of data** that the online system presents. Users cannot see those until they **connect the device** to the computer; however seeing the graphs and making implications about the data was stated to be the most important part of using the system.

FB participants did not make as much negative comments as BM participants did, as they could be able to **reach data** through the display of the device. Still, FB users were concerned about the **details of the graphs** they see through online system. They stated that the graphs and information the system gives are easy to understand, but they expected some of these to be more **expressive in telling** what it implies, such as active score which they couldn't understand. As a major expectation, all participants expected the systems **prompt the user by analyzing their data**. Doing this, participants expect the system to **give meaningful suggestions** and achievable goals about being active or eating less. These show that, the ability of system to give **instant and personal feedback** is vital for these systems to engage users

Usefulness

In total, FB participants talked more about usefulness of the system than BM users. FB made more positive comments than BM participants, while BM participants made more negative comments than FB participants. Moreover, percentage of negative comments of BM users was more than their positive comments, while BM participants made less comments about their expectations compared to FB users.

Participants, who were positive about how the system helped them to reach their initial goals, related this to "usefulness" of the system. All users agreed on the fact that these types of systems can help people to learn the calories they burn, and steps they take, but all expected the **data to be easy to access**, and the systems to have better ways to **reach and interpret the data**.

BM users had interaction problems (see ease of interaction) and this affected the way they evaluate the usefulness of the system. Having these problems, participants could not get maximum benefit from the system which resulted in the negative comments about the usefulness, and expectations about solving the usability problems. On the other hand, FB participants did not have critical interaction problems and could get the data from the device itself, which are the main reasons of positive comments. Still, the main critique of the system was that, after a while FB was perceived as a pedometer, rather than a fully personal product that measures personal activity. Therefore, using the system with full performance, FB participants expected the system not just to record the steps but record everything the user does, which is also related to the smartness of the device (see smartness).

The main agreement between the participants was that they stated the positive effect of "logging food" on their perception of calorie balance and awareness of self: the device was able to measure the physical activity and when they log food, they were able to see the difference between calorie –intake and calories burned. However, four of the BM participants stated that the database of BM system does not work well as they had problems with food logging. One major issue was that the data base was not

stated to be rich enough to find the type of food they eat. On the other hand two of the FB users used another application and online system (MyFitnessPal) which can be synchronized with FB system. Those participants indicated that it was easy to log food with another system that they were used to. Still, others expected the systems to have better food database and way of food logging so that it could be more useful for them.

Table 15. Hierarchy of Product Centered Factors in reference to Mention Percentages

Quality	***Total***	***User***	***Positive***	***Negative***	***Expectation***	***Total***
meaningful data and interactions	14.15	BM	2.09	3.03	2.89	8.01
		FB	2.51	1.78	1.84	6.14
usefulness	13.88	BM	2.42	2.78	1.35	6.55
		FB	3.28	2.38	1.67	7.33
social experience	8.77	BM	1.70	1.81	1.18	4.69
		FB	2.39	0.95	0.74	4.08
ease of interaction	8.21	BM	1.11	2.70	1.49	5.30
		FB	1.34	0.94	0.62	2.91
pleasure in use	6.47	BM	1.41	0.51	0.71	2.63
		FB	2.04	0.75	1.05	3.84
smartness	3.86	BM	0.11	0.25	0.94	1.31
		FB	0.15	0.35	2.05	2.55
accuracy	3.70	BM	0.22	1.34	0.42	1.98
		FB	0.31	1.07	0.34	1.72
pleasing aesthetics	2.99	BM	0.53	0.38	0.44	1.35
		FB	1.16	0.29	0.20	1.64
personalization	2.84	BM	0.03	0.21	0.87	1.11
		FB	0.00	0.20	1.53	1.73
comfort in mobility	2.74	BM	0.12	1.08	0.40	1.60
		FB	0.56	0.39	0.19	1.14
ease of communication	2.59	BM	0.18	0.81	0.84	1.82
		FB	0.47	0.00	0.29	0.77
compactness	0.96	BM	0.02	0.22	0.31	0.55
		FB	0.33	0.06	0.02	0.41
systematic design	0.86	BM	0.00	0.36	0.31	0.67
		FB	0.00	0.10	0.09	0.19
privacy	0.69	BM	0.05	0.32	0.03	0.40
		FB	0.13	0.08	0.08	0.29
customization	0.33	BM	0.00	0.02	0.07	0.10
		FB	0.06	0.00	0.17	0.23
context awareness	0.33	BM	0.00	0.00	0.01	0.01
		FB	0.00	0.00	0.32	0.32
simplicity	0.18	BM	0.00	0.00	0.00	0.00
		FB	0.18	0.00	0.00	0.18
TOTAL	73.56		24.90	25.16	23.50	73.56

Social experience

In total, BM participants talked more about social experience than FB users. FB users were obviously more positive about the social experience, while BM participants were more negative.

The reason why FB participants made more positive comments is that, FB created **good conversations** with other people, while BM participants were annoyed when the **device catches attention** (which can be regarded as similar problem stated in Study1). In relation, FB participants were happy to talk with friends about the system and how it works. This situation depends on user's willingness to show the device as it is mostly hidden. They stated that they shared their data with other people they know through the device (as data was available on the interface of the device) which created good conversation with their friends. Even one of the FB participants stated how she was

socially proud of using it (FB03). On the other hand, as BM is worn on upper arm and is visible to the people, it created **constrained conversation** with others. When they were asked about the device, they stated that they talked about the device as part of a study. This can be regarded as an implication of people's not being **happy with carrying** the device. Male participants actually were not that concerned about the appearance of the device considering the social norms. On the other hand, one of the male participants frustrated when it "beeped" in a meeting.

As was also the concern of the participants of Study1, all female users of BM mentioned about visibility of the device and they were more annoyed to carry the device while going to social occasions. Those stated that it is not **appropriate to wear** the device in social occasions, such as going to opera, a wedding or a commencement. Only one of the female BM participants was happy with visibility, as she was trying to motivate people to be active. This is why they expected it to be **less obvious and less intruding** (see also aesthetically pleasing).

Another type of social experience was **sharing personal data** with people through online system. Most of the participants were not interested in sharing their data with people who they don't know. One of the FB participants stated that, he would be interested in sharing data only if the data were anonymous. Another FB participant stated that she could share it with people whom they know, only if these people are also using the same system. Rest of the participants was not totally interested in sharing their data as they didn't want their personal

Ease of Interaction

In total, FB participants talked less about the ease of interaction the system than BM users. Even though the positive comments about both systems seemed equal, BM users made more negative comments than FB users, and as expected, they wanted to change the system more than FB users.

While talking about the ease of interaction of the systems, participants mentioned about their concerns about the way system gives the data. FB users were all positive about the way they interact with the data. It was easy for them to **reach it instantly**, which seemed the most important advantage of using FB.

The reason why BM participants made more negative comments is that, four of the 8 participants had problems in **connecting the device** with the phone and computer. BM users had to make required connections with the phone each time. If not wanted, user had to connect the device to the computer which did not seem practical for the participants. In addition, three of the BM participants were Android phone users and the system did not provide as easy connection as it offers to IPhone users. This resulted in complains about using the system as the users couldn't learn their data unless they connected the device to the computer. Moreover, two of these were using IOS in their computer and they had problems in **connecting the device** to the online system. Trying to solve the problem, it was realized that, BM updated the software for IOS without showing relevant notification for this update. Having the previous version, sync system was just saying "a problem occurred" without saying what the problem was. This resulted in the users' not being able to understand what the problem was. This usability problem also resulted in losing users' interest in using the system.

Another issue related to ease of interaction was learning calorie intake data. In the study, participants tried to use the application for logging food. As stated in explanation of usefulness, two FB participants used another system to log food, which they stated to be easier to learn what they consume. Still, related to the explanations of usefulness, participants expected easier ways to log their food. As major expectation, participants desired the system to understand what they eat without requiring their efforts.

Pleasure in Use

FB participants mentioned more positively than BM participants about pleasure in use. Frequency of negative comments and expectations of FB participants are more than BM participants as well.

The reason why FB participants were more positive than BM participants is that, FB participants especially indicated that they liked using the product, but BM participants did not emphasized on

pleasure in use. FB participants were more positive, as they had fun with using the system while BM participants enjoyed just **seeing the data**, especially the sleep data. The growing "flower" on the interface of the FB device when people became more active indicated to be pleasure in FB experience. **Interacting with this visual representation**, it became like a game for FB participants to have fun with the device. Still both BM and FB participant expected it to offer more **interaction back**, such as poking, vibrating or beeping to help the participant understand the level of the interaction and suggest things to do by surprising the participant.

Smartness

FB participants talked about smartness of the system more than BM participants. FB participants stated more positive and negative comments than BM. Percentage of expectations are much more than BM participants as well.

The reason for the difference between percentages of expectation comments comes from people's expectation of smartness; FB system was expected to be smarter than the current one. It was because, after a while, the data became routine and participants expected the system to **analyze the data instantly and make instant suggestions**. Moreover, participants expect the system to know everything about the participants' body. In other words, using the system in full performance, participants expected the system to be as smart as a "**personal trainer**."

Accuracy

It is standing out that BM participants talked more than FB participants about accuracy of the system. This result comes from the negative comments and expectations of BM participants.

All participants expected the systems to give accurate data, however BM participants were suspicious about the estimations of calorie count and food logging system. For instance one of the BM participants stated that the online system told "*7 minutes of vigorous activity when she was dying*" (BM06). Similarly, one of the BM participants was skeptical about the sleep tracking function. Those actually resulted from the vagueness in data measurement: participants expected to learn about how it calculates the calories burned and sleep activity; then they would be sure that the device is **measuring accurately**.

Differently, FB participants had comments related to number of steps taken. In general, as FB measurements are based on number of steps and was perceived as a pedometer, participants expected accuracy in "quality of steps". One of the main concerns was that the device cannot distinguish the size of the steps. While two of the participants indicated that the device felt short for display number of steps correctly, another participant indicated her reliance on the device as it calculates each step as "1" no matter how big they are. That participant expected the system to ask for the length of her stride to measure the accurate distance she travels on foot. These ambiguities resulted in participants' needs to learn the accurate calculations of themselves, rather than learning about the "assumptions".

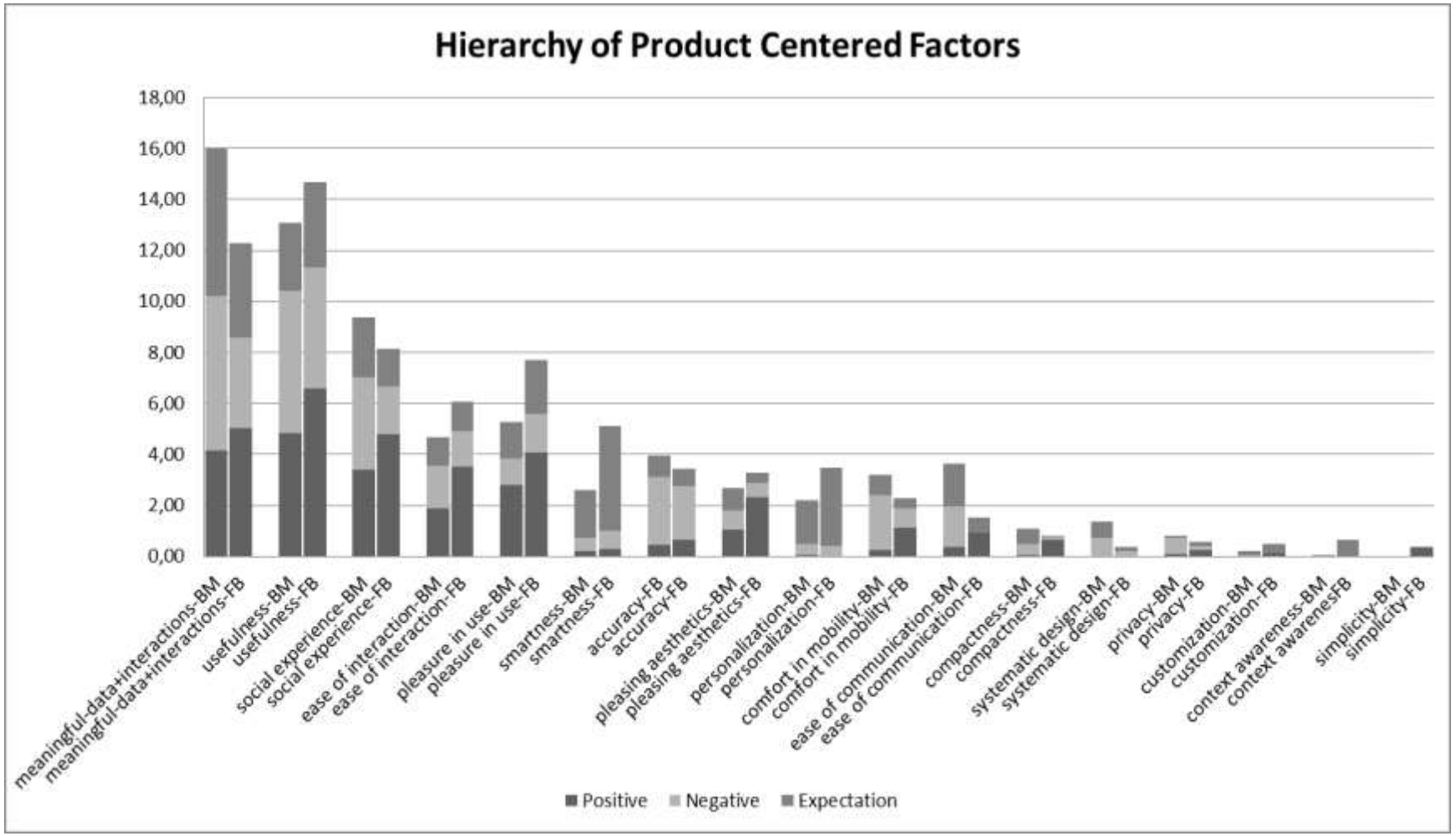

Figure 40. Hierarchy of Product Centered Factors in reference to Mention Percentages

Pleasing Aesthetics
FB participants mentioned slightly more than BM participants about pleasing aesthetics. While FB participants stated more positive than BM participants, BM participants stated more negative comments and expected those to be changed.

FB participants were more positive as they liked the appearance, **form, size and color** of the device as well as the appearance of the website; they find it "cute" and "cool" in terms of the aesthetics. One of the participants stated that "*it is still simple which can be beautiful" (FB01)* which summarize idea of FB participants.

Results of BM participants are close to the results of Study1; but participants can be divided into two as the idea of female and male participants change a lot in terms of the appearance of the device. While male participants were not unhappy with the appearance, female participants complained about the size and shape of the device. They also complained about the **visibility of the device** in relation to **mobility of the device**. These explain why BM participants mentioned more negatively than FB participants, which also explain the reasons for size related expectations of BM participants.

Personalization
FB participants did not make any positive comments about the system, but mentioned about the personalization as of their expectations. Similarly, BM participants expected the system to offer better characteristics that the participant can personalize. Those were because personalization is not a quality of the system but it is expected from the future systems.

FB participants expected the system to be changed so that it will be "**tailored**" to the user. For instance, the system was expected to "**talk about**" the participant specifically, rather than just collecting data and analyzing it according to pre-defined parameters. Similarly, both FB and BM participants expected the systems to **make suggestions** about the user by analyzing their data. In addition, BM participants expected the device to be **adaptive to the user**, by being able to be worn on different parts of the body.

Comfort in Mobility
BM participants mentioned about the comfort in mobility more than FB participants. While percentage of negative comments of BM participants is more than positive comments, they expected the system to be changed more, compared to FB participants.

BM participants talked about the problems of slippage (similar to Study1), while using the system. For instance, one of the participants stated that it slipped down while she was running (BM03). Similarly, another BM participant was concerned about the **position of the device** on the upper arm. Disturbance while sleeping was listed a major problem of early days. Getting used to the idea of sleeping with the device on the arm caused this problem while one of the participants had problems of itches after the early days of usage, which caused him to stop using at the end.

FB participants were positive about the device as it was **small and clippable** and participant can carry wherever they want. On the other hand, the main negative comment about FB was that, as it is small, the participant could **easily lose it**, as one of the participants lost the device while he was running and had to be supplied with a new one.

Ease of Communication
Ease of communication is closely related to ease of interaction, but was used when participants specifically stressed on the communication with the device. That's why, even though it is as important as ease of interaction, the number of comments is not as high as ease of interaction.

BM participants mentioned about the ease of communication more than FB participants. The percentage of negative comments and expectations of BM participants are higher than positive comments, while FB participants were positive about the system and made a couple of comments about their expectation.

The main problems of BM participants comes in to prominence again, as they thought that the **communication** between the device, the mobile phone and the online system is not **fluid** enough to **provide efficient feedback**. Device's beeping randomly and not beeping when the device is on (to show that it is working) were the main problems of communication with the device. Other than these, as was explained in ease of interaction, the communication of the device with the phone was problematic and the participant could not understand what the problem was. FB participants mentioned about the interaction with **visual presentation** "the flower" as an impressive way of communicating way of interacting with the data.

Other Factors

The factors that were mentioned less than %2 in total will be given in the table below (Table 16) as the number of participants mentioned these qualities is limited, but still needs to be mentioned as a minor dimension of participant engagement.

Table 16. Other Product Centered Factors

Factor	***Explanation***
Compactness	Mostly, the **size** of the BM device was criticized to be big to be carried on the upper arm, while FB participants were mostly positive about the compactness of the device. BM participants expected the device to be reasonable in size.
Systematic design	It is expected that the systems should offer consistent visual language within itself such as repeating the same **visual language** in both online system and application. In addition, consistency within all data presentation is expected; the application and online system should show the same kind of data.
Privacy	Mostly, BM participants mentioned about the privacy of the device as it is visible and perceivable. In relation to compactness of the device, they expected it to be smaller in size to protect their privacy, as its size resulted in sharing their experience with other people involuntariness. In addition, data sharing was also mentioned in relation to privacy, however only a few of the participants stated that sharing data especially with their friends would be helpful, but they are not interested in sharing it only if the privacy of the data is supplied.
Customization	Only 3 of the participants emphasized on customization. The main agreement within these participants was that they expected the online system to be customizable in relation to their personal priorities. For instance, one of them stated that the interface could be customized so that the participant would be able to change the location of the data or even hide what they don't care.
Context Awareness	Two of the FB participants listed context awareness within their expectations. Those emphasized that the system could be able to track where the participant is and could **make suggestions about alternative ways of being active**. In addition, the location and physical activity information is expected to be combined in order participant to remember their activities better. One of the BM participants stated that, it would be contextually aware enough to know the right moment to remind him to work out, which is also related to what FB participants expected.
Simplicity	3 FB participants emphasized on the **simplicity of the form** of the device and they indicated that "one button thing" like IPhone makes the device both simple and "beautiful" at the same time.

To sum up, all the explained product centered factors clarify what people care most. Meaningful data and interactions, usefulness and social experience are the top three important factors that affect participant engagement. The least emphasized ones are the minor qualities but still are needed to be addressed to draw the general model of user engagement of personal informatics systems.

6.2. QUESTION2: WHAT ARE THE HUMAN-CENTERED RESULTS OF USING THE SYSTEM IN LONG TERM?

This sub question will be answered through the human centered factors, initial goals and stages of change of participants sections. *Human centered factors section* covers hierarchy of system qualities related to people's personal changes and their initial intentions, distractors and uncertainties about future; *initial goals of participants* section covers participants' initial goals and whether they achieved those goals during 5-weeks' study and *stages of change* section covers participant' first and final physical activity levels (Figure 39)

6.2.1. HUMAN CENTERED FACTORS

Similar to the Chapter 5, in this section, personal changes that participants mentioned during the interviews at the end of the 5 weeks, are explored The mention frequency of system qualities that participants mentioned varies, thus each quality will be explored respectively (The details of data analysis were listed in Table 17 and

Figure 41.

Table 17. Hierarchy of Human Centered Factors in reference to Mention Frequencies

Quality	***Total***	***Participant***	***Positive***	***Negative***	***Expectation***	***Total***
motivation	8.52	BM	1.26	0.46	1.60	3.32
		FB	1.83	0.96	2.40	5.20
curiosity	3.37	BM	0.76	0.31	0.26	1.34
		FB	1.10	0.31	0.62	2.03
engage	2.90	BM	0.57	0.51	0.28	1.36
		FB	0.58	0.38	0.58	1.53
realization	2.38	BM	1.06	0.14	0.03	1.23
		FB	0.73	0.37	0.05	1.15
feel good	2.15	BM	0.22	0.57	0.14	0.93
		FB	0.72	0.42	0.07	1.22
behavior-change	1.96	BM	1.08	0.35	0.02	1.44
		FB	0.46	0.04	0.02	0.52
awareness	1.48	BM	0.49	0.07	0.09	0.65
		FB	0.72	0.07	0.05	0.83
excitement	1.09	BM	0.39	0.07	0.00	0.46
		FB	0.51	0.13	0.00	0.63
interest	0.92	BM	0.19	0.11	0.12	0.41
		FB	0.35	0.09	0.08	0.51
habitualization of usages	0.89	BM	0.10	0.19	0.02	0.31
		FB	0.27	0.27	0.05	0.58
annoying	0.63	BM	0.00	0.38	0.00	0.38
		FB	0.00	0.26	0.00	0.26
disappointment	0.14	BM	0.00	0.06	0.03	0.09
		FB	0.00	0.03	0.01	0.05
TOTAL	26.44		13.40	6.54	6.50	26.44

Motivation

According to comparisons (Table 17) both BM and FB participants talked about their motivation more than other personal factors. Surprisingly, FB participants made more negative comments than BM

participants and BM participants made more positive comments than FB participants. Also, FB participants expected the system to be changed in better way to be better motivated.

The reasons behind number of FB participants' comments on their motivation vary. For instance, three of the participants (FB01, FB02, and FB07) related their low motivation with the interaction with the device: They expected the device to **prompt the user** to motivate them to do more physical activity; however they thought that the device was only giving information, rather than **specific messages to motivate** them. Therefore, just looking at the device did not motivate them. Even, other FB participants expected the system to **give advice** or to **suggest possible physical activities by analyzing their daily activities, calories burned and calories taken. Another FB participant** had been using another log-system to log her food, and she had already been losing weight with that program. Believing the usefulness of that system, she expected FB to motivate her more than the log-based-system. For her, the data seemed to repeat itself. That's why she lost her motivation to reach the initial goals defined at the beginning. Rest of the FB participants was mostly positive about the way the system motivated them. For instance, FB03 stated that she was so motivated that she bought the device for 4 of her friends. She thought that it would be a good present for her friends. Still, all of the FB participants expected the system to notify the participant about this/her progress and reward for the good progress.

When it comes to BM participants, it was observed that BM participants were more motivated to be active regardless of the device, and the system made little contribution to their motivation. Similar to FB, BM participants expected these systems to be smart enough to encourage them to be more active. Problems in **interaction with the data** were indicated to be motivation breaker for BM participants.

Curiosity

FB participants made more positive comments and indicated more expectations than BM participants. According to the participants' comments, curiosity is closely related to motivation: If the data becomes the same, or if the system does not work well, they lose their curiosity and thus their motivation. Thus, learning about all the personal data is one of the major reasons of losing curiosity.

BM participants were mostly curious at specific times of day such as in the morning, or after doing specific kinds of activities such as after going to gym. Again, not being able to **see data** (interaction problems) resulted in decrease in curiosity. As device required syncing with the online system to see the graphs of daily activities, participants had to sync it which resulted in a burden for participants. Still, participants were positive to be able to see their activity data through the system. Especially sleep data made participants curious about their sleep efficiency, thus most of the BM participants preferred to sync it in the mornings.

FB participants had the ability to see the data instantly through the small interface of the device, thus this affected their positive comments about the effect of "**availability of data**" on their curiosity. They were able to check data whenever they were curious, and similar to BM participants, FB participants were more curious when they exercised. On the other hand, expectations of FB participants were on "**what the data means**" and how it measures the data, and they required it to give evidences or explanations of **what the data represents.**

Overall, the major problem in curiosity was that both BM and FB participants stated that the data starts to repeat itself after a while and not getting suggestions about how to break the monotony of data resulted in decrease in curiosity.

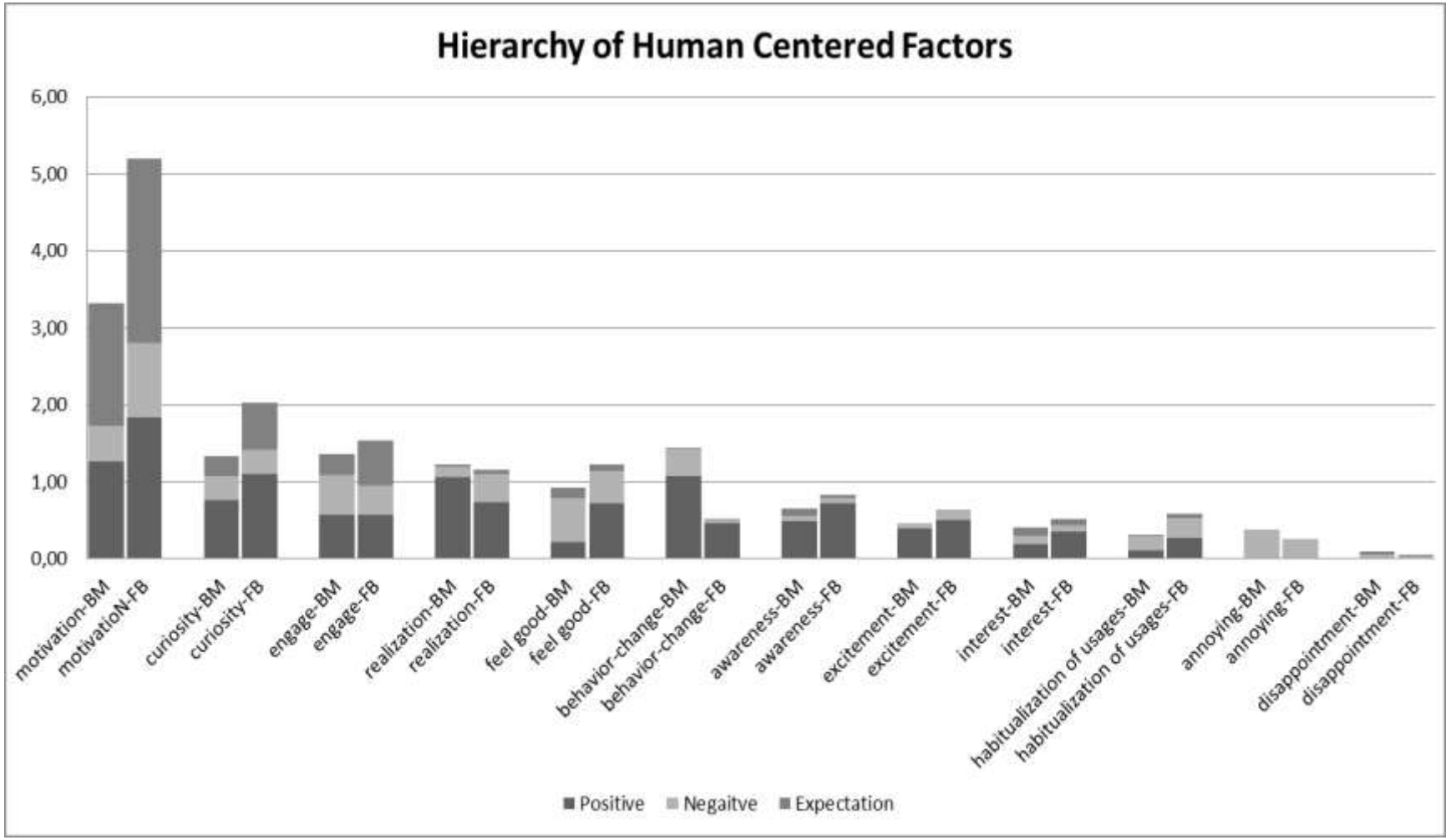

Figure 41. Hierarchy of Human Centered Factors in reference to Mention Percentages

Engage
FB participants made more comments about their engagement with the system and most of these were positive comments and expectations. FB participants stated to be more positively engaged than BM participants and they were less negative than BM participants.

All participants found it engaging to check data and to see how active they were. FB participants found some of the characteristics least engaging, such as data sharing, activity logging, activity score (that they don't understand what it is). Both FB and BM participants stressed on the lack of interactivity as the reason of less engagement. One of them stated that, if the user is inactive during the day, it becomes the reason to ignore the device, which results in less engaging experience. Four of the BM participants, who had problems in **seeing instant data** and they related engaging experience with the quality of interaction with the systems. Not being able to see the data, they lost their enthusiasm in the system and thus found it less engaging.

Game-like usage would keep people engaged with the system. For instance, two of the BM participants stated that logging food and learning the calorie deficit became like a game to try to figure out what they can do for themselves. For most of the FB participants, using the device and interacting with to learn about themselves was the most engaging part of experiencing it.

Realization
Both BM and FB participants made more positive comments about realization while FB participants made more negative comments.

It was obvious that, both BM and FB systems helped participants to realize their sleep efficiency, activity data, calories burned and calories taken. Both were pleased to especially see their sleep data and make connections between their physical activities. Systems helped participants to realize that specific activities result in taking higher number of steps and burning higher number calories. Still, **roughness of the data** was criticized, and as an expectation, one of the BM participants stated that labeling online graphs would work for not estimation but for exactness of calories burned in a day.

Feeling Good
The comments were mostly made while participants were talking about the answers of the question that was asked in evaluation part of the study. FB participants were positive while BM participants were negative, mostly related to what have been explained until here.

Mostly, participants stated that feeling good is not related to the system but the abilities of the system or the consequences of using the system. BM participants stated implications when they didn't feel good in relation to changes in their body. As an example, one of the BM participants stated that losing weight makes him stressful. In association with what it offers, FB participants were more positive as they had fun with using the system.

Other Factors
In the previous section, factors that had small percentages (less than %2) were listed as minor qualities. In this section, they will also be listed as minor ones and are listed in Table 18.

Table 18. Other Human Centered Factors

Factor	*Explanation*
Behavior change	There are two domains that participants stated that the system helped them to encourage them to change behavior. First, logging the food every day, the system helped participant to **keep track of** what they eat, and helped them to cut some of the unhealthy food they eat. However, this only helped participants who were volunteered to log food. Second, seeing the calories burned or number of steps taken, some of the participants **felt accountable** and wanted to reach their daily goals. While some of the participants were interested in losing weight or keeping track of themselves, system had no effect on them as they were already using another system, the system did not as interactive as they expected or they had usability problems in reaching data.
Awareness	In relation to the findings listed under realization, participants were mostly glad to **learn** their activity data, calories burned, sleep data and calorie intake. Learning those all stated that being aware of them helped them to **be educated** on what they are doing and elaborate on what they should avoid.
Excitement	FB participants were more excited to use the system and to **observe the outcomes**. Having good social experience, FB participants indicated their excitement in **sharing their experience with their friends**. Getting good feedback from them was also a reason for their increasing excitement. Especially one of the FB participants reflected on how excited she felt after using the system and how she improved her activity level by just seeing the data. Within all participants, 4 (2 BM, 2 FB) of them were feeling more excitement as they were excited to see how the system helped them to lose weight.
Interest	FB participants were slightly more positive in terms of their interest. Both BM and FB participants were interested in learning the sleep data and seeing the online graphs which indicate that both were interested in "**seeing unknown part of themselves**". Still, BM participants indicated that they would be more interested only if they could **reach data instantly**.
Habitualization of usages	BM participants made more negative comments on habitualization of usage as they stated that the data started to repeat itself and they "had all information needed" and calories burned were the same day to day. FB participants complained about the same problem, as data became routine on routine days, but still those who made positive comments stated that they got used to using it and it became a part of their life.
Annoying	BM participants were annoyed with data syncing problems which is related to interaction of the system while FB participants were more annoyed about food logging function of the system.
Disappointment	Not being able to see data instantly and having "funny feedback from the online system" was the minor reasons of disappointment of BM participants. Only 1 FB participant mentioned the disappointment she experienced when she realized that she couldn't lose weight even though the physical activity level that the device showed was high.

Personal challenges, distractors and uncertainties

Regardless of using the system, challenges, distractors and uncertainties about future behavior were mentioned as part of influential of engagement.

Both FB participants (2 of them) and BM participants (6 of them) stated that having someone in their life to encourage them to accompany their physical activity would be more challenging than having personal challenges. One of the BM participants stated that she used to make commitments about being more active, when she realized how inactive she was. In general, participants stated that committing to become more active or to lose weight were the specified personal challenges that participants mostly made about themselves regardless of the study. While trying to achieve their commitments, changes in daily routines or personal expectations were stated to distract what people would like to do. These include additional responsibilities or too time consuming work at work, birthdays, short holidays, weddings, or not losing weight after a while.

There were uncertainties stated by participants about their future behaviors. For instance, they were uncertain about whether they would still be active after the study, as they thought that the system created **accountability to be active**. In addition, some of the participants were logging what they eat during the day. Those were also unsure whether they would pay attention to that.

During the interviews, participants were also asked whether they would like to keep using the system. Referring to their lost curiosity, 3 of the FB participants responded negatively, as they expected the system to change in a way that the system can maintain their curiosity and motivation. Rest of the FB participants was highly keen on using the system while one of them already purchased the device for herself. On the other hand, only 2 of the BM participants responded positively, as they were able to make the application **communicate with the device properly**. Rest of the BM participants, referring to their interaction and aesthetical needs and expectations, responded negatively as the system lack in **satisfying their initial needs**. The logs of frequency of system access also showed that FB participants explored their data more frequently than BM participants.

Table 19 also shows the details of participants' willingness states to use the system at the end of the study.

Table 19. Participants' willingness levels to use the system at the end of the study

Participant	***Will/not will to use***
BM02	☑Bought one
BM03	☑Want to buy one
BM04	☒No
BM05	☒No
BM06	☒No
BM07	☒No
BM08	☒Maybe while doing an activity, but can't buy the device for that reason
BM09	☒No
FB01	☒No
FB02	☒No
FB03	☑Bought one (and for her friends)
FB04	☑Yes
FB05	☑Yes
FB06	☑Yes
FB07	☒ No
FB08	☑ 3 weeks after the study, he emailed saying that he bought one from Craigslist

6.2.2. INITIAL GOALS OF PARTICIPANTS TO USE THE SYSTEM

At the beginning, during the initial interview, participants were asked to talk about their goals to be participants of this study and at the end of the study they were asked whether they had achieved these goals. All of the participants stated that they wanted to maintain or increase their activity level and/or lose weight. Their responses, at the end of the study showed that, FB participants felt more successful in achieving these goals than BM participants.

Interview data highlights that, the system helped only 3 of the BM participants to achieve some of their goals, while rest of them stated that the system has no effect on their behavior. In general, BM participants were not convinced that the system had helped them to become more aware of, or subsequently change, their behavior, while all eight FB participants mentioned at least one positive effect of the system in achieving their goals. For example, FB03 describes how data visualizations helped her to increase her activity more and more, and also believed that it would make other people happy to use the system. 6 of the FB participants mentioned that the system explicitly helped to increase their activity, and two of them stated that it helped them to lose weight. However, only three of the BM participants mentioned an increase in their physical activity, and two of them stated it helped them to lose weight.

Table 20. Initial goals of participants and role of the system in achieving these goals

Participant	*Initial Goal*	*Role of System in Achievement*
BM02	(1) Lose weight	☑ Yes (Lost 8 pounds)
	(2) Learn about self	☑ Yes
BM03	(1) Lose weight	☑ Yes (Lost 10 pounds)
	(2) Learn about self	☑ Yes
BM04	(1) Learn about self	☒ No (Device did not work properly)
	(2) Keep activity level	☒ No (was too busy)
BM05	(1) Lose weight	☒ No (Device did not work properly)
	(2) Learn about self	☒ No (did not trust in the device)
BM06	(1) Lose weight	☒ No (just 1-2 pounds)
	(2) Learn about self	☑ Yes
	(3) Keep activity level	☒ No (kept level but device did not help)
BM07	(1) Lose weight	☒ No (lost a couple but device did not help)
	(2) Learn about self	☑ Yes (but not to the level participant expected)
BM08	(1) Learn about self	☑ Yes
	(2) Keep/increase activity level	☑ Yes
BM09	(1) Lose weight	☒ No (Lost weight but no role of device)
	(2) Learn about self	☑ Yes
FB01	(1) Lose weight	☒ No (Lost weight but no role of device)
	(2) Learn about self	☑ Yes
FB02	(1) Lose weight	☒ No (Lost weight but no role of device)
	(2) Learn about self	☑ Yes
FB03	(1) Lose weight	☑ Yes (Lost 8 pounds)
	(2) Keep/increase activity level	☑ Yes (Started doing more activity)
	(3) Learn about self	☑ Yes
FB04	(1) Keep/increase activity level	☑ Yes
	(2) Learn about self	☑ Yes
FB05	(1) Learn about self	☑ Yes
	(2) Keep/increase activity level	☑ Yes
FB06	(1) Learn about self	☑ Yes
	(2) Keep/increase activity level	☑ Yes
FB07	(1) Learn about self	☑ Yes
	(2) Keep/increase activity level	☒ No
FB08	(1) Learn about self	☑ Yes
	(2) Keep/increase activity level	☑ Yes

6.2.3. RESULTS OF STAGES OF CHANGE

Similar to the first study, participants were asked to fill the Stages of Change Scale both at the beginning and at the end of 5 weeks. According to the Stages of Change scale results, (Table 21), at the beginning3 of the participants were at pre-contemplation stage; 3 were at preparation, 4 were at action and 7 were at maintenance stages. None of the participants were at contemplation stage.

Table 21. Distribution of Initial Physical Activity Stages

	BM	*FB*	*Total*
Stage2-Precontemplation	1	2	3
Stage3-Preparation	3	2	5
Stage4-Action	1	2	3
Stage5-Maintenance	3	2	5
Total	8	8	16

At the end of the study, 3 out of 8 of the FB participants stated positive behavior change while 4 of them finished the study with no change in initial stage. 1 of them stated to change behavior negatively. On the other hand, 4 of the BM participants stated to change their activity behavior positively. 2 of them declared to change negatively and 2 of them remained the same. Details of each participant are given in Table 22.

Table 22. Changes in Stages of Activities in Detail

Age	Participant	First Stage	Final Stage	Gender
50	bm02	5	3	Male
57	bm03	3	5	Female
23	bm04	4	5	Male
34	bm05	4	3	Female
24	bm06	5	5	Female
41	bm07	3	5	Male
27	bm08	2	4	Female
28	bm09	5	5	Male
29	fb01	2	3	Female
40	fb02	3	2	Female
47	fb03	5	5	Female
29	fb04	5	5	Male
46	fb05	3	4	Male
35	fb06	2	3	Male
33	fb07	3	3	Female
26	fb08	5	5	Male

All human centered results demonstrate the effect of product centered factors on human centered results of using the system. In addition, engagement with the system also affects the willingness to use the system. In relation, how people's evaluation of the system changes in the long term usage will be explained in the next section.

6.3. QUESTION 3: HOW DO PEOPLE'S EVALUATION OF THE SYSTEM CHANGE IN LONG TERM USAGE?

This sub question will be answered through the results of the daily reports and final evaluations. These cover 9 questions asked at the end of each day and during the final interview. Each question will be explained with relative graphs.

6.3.1. RESULTS OF THE DAILY REPORTS AND FINAL EVALUATIONS

To explore the results, mean values of first week, fourth week and final evaluation were calculated and represented with graphs. Following this, correlations between each question were calculated to find out the relations. All listed evaluations of all BM and FB used were used to find the correlations between engaging experience and the rest of the 8 questions. The questions can also be divided into two as product centered and human centered questions.

6.3.2. PRODUCT CENTERED QUESTIONS

Question 1: Functions poor / well: At the beginning, both BM and FB participants were positive that both systems function well (*M*: BM=5.17; FB=5.33). However, through the end of the study, FB participants became more positive (*M*=5.46) while BM participants became more negative (M=4.65). When participants were asked to evaluate the overall experience in terms of the functions, the same finding can be observed (*M*: BM=4.88; FB=5.63). These results show that, FB participants were more satisfied with the system compared to the BM participants (Figure 42).

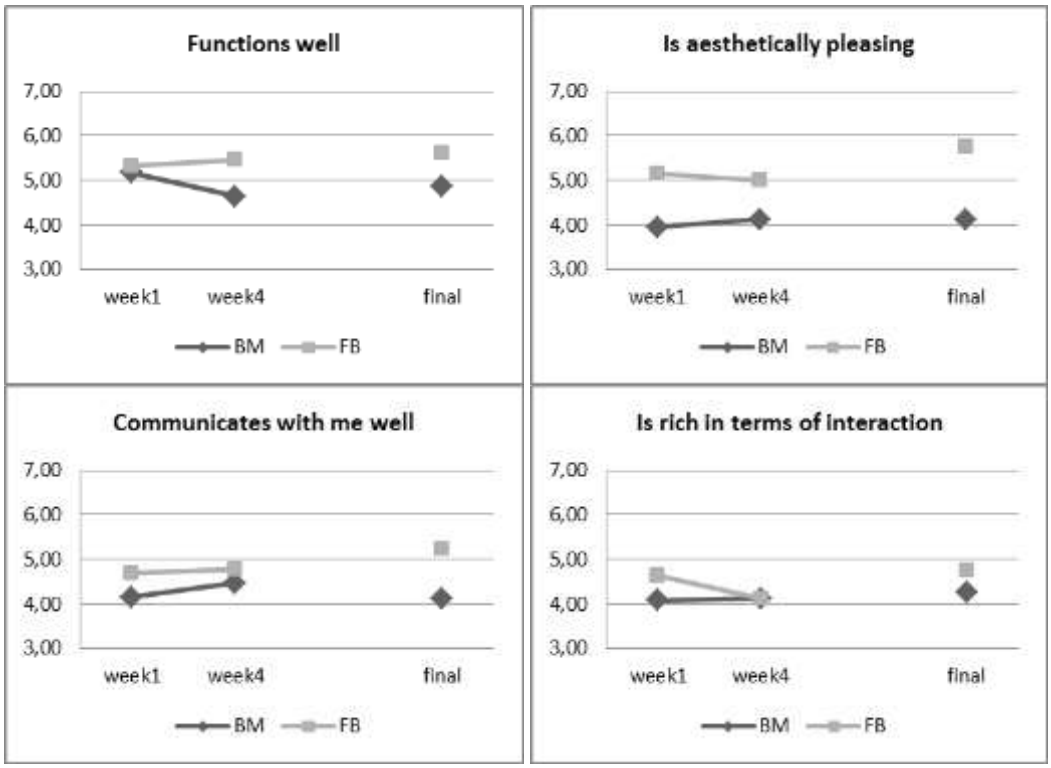

Figure 42. Evaluation of Product Centered Questions

Question 4: Is not aesthetically pleasing/ is aesthetically pleasing: At the beginning, FB participants were much more positive towards the aesthetics of the system compared to BM participants (*M*: BM=3.95; FB=5.15). At the end of 4th week, FB participants were slightly negative compared to initial week (*M*=5.00) but BM participants were slightly positive compared to the results of the first week (*M*=4.13). However, when participants were asked to evaluate their overall ideas about aesthetics of the system, FB participants stated to be positive (*M*=5.75) compared to BM participants (*M*=4.13). These indicate that FB participants were always more positive towards the aesthetics of the system compared to BM (Figure 42).

Question 5: Communicates with me poor / well: FB participants more positive about communication of the system compared to BM (*M*: BM=4.15; FB=4.70). At the end of 4th week, even though the idea of FB participants did not change much compared to initial week (*M*=4.78), BM participants were slightly positive compared to the results of the first week (*M*=4.47). When were asked to evaluate their overall ideas about communication of the system, FB participants stated to be much more positive (*M*=5.25) than BM participants (*M*=4.13). BM participants rated less than the final week at the end. In general, FB participants were more positive about the communication of the system compared to BM participants (Figure 42).

Question 8: Is poor/rich in terms of interaction: At the beginning, FB participants were more positive compared to BM participants (*M*: BM=4.08; FB=4.64). At the end of the 4th week, both FB and BM participants were equal about the richness of interaction with the systems they used (*M*: BM=4.15; FB=4.15). At the end, FB participants were more positive (*M*=4.75) than BM participants (*M*=4.25). Results show that, considering the overall experience, FB is richer than BM in terms of interaction. However, during the usage period, FB participants started to think that the system is not that rich (Figure 42).

6.3.3. HUMAN CENTERED QUESTIONS

Question 2: Does not make me feel good/ Makes me feel good: At the beginning, FB participants were thinking that the system made them feel more positive compared BM participants (*M*: BM=4.68, FB=5.08). At the end of 4th week, the difference between the FB and BM evaluations came closer, while FB participants thought that the system made them feel less good (*M*=4.85) compared to BM participants (*M*=4.66). These results show that, BM participants' emotions did not change much compared to the FB participants. When participants were asked to evaluate the overall experience in terms of their feelings, FB participants stated to have felt good (*M*=5.13) while BM participants stated to have felt less good (*M*=4.75). It was surprising that, both BM and FB participants rated their overall feelings slightly higher than their weekly-based ratings (Figure 43).

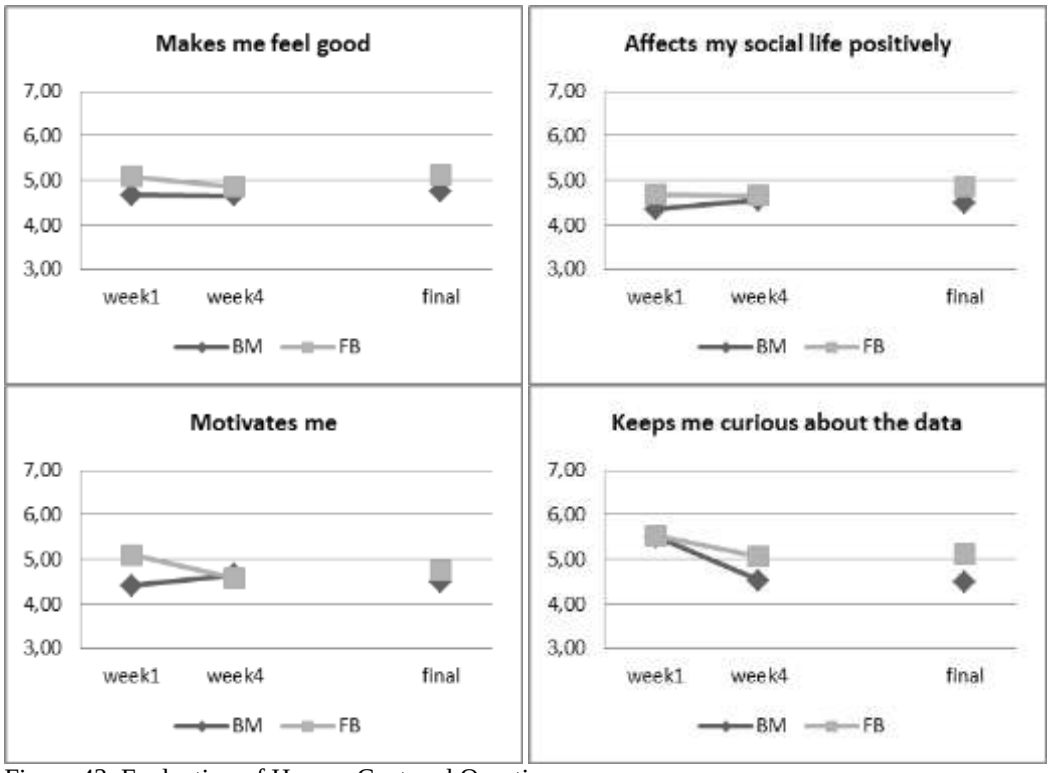

Figure 43. Evaluation of Human Centered Questions

Question 3: Affects my social life negatively / positively: At the beginning, FB participants evaluated the effect of the system on their social life slightly higher than BM participants (*M*: BM=4.36; FB =4.68). At the end of 4th week, ideas of FB participants did not change much (*M*=4.66) while BM participants indicated slightly more positive effect compared to first week (*M*=4.56). Overall, FB participants stated more positive effect (*M*=4.88) than BM participants (*M*=4.50).

Question 6: Does not motivate me / motivates me: In the early days**,** FB participants stated to be motivated by the system more than BM participants (*M*: BM=4.41; FB=5.10). However, at the end of 4th week, FB participants were less motivated (*M*=4.57) compared to the first week and were slightly less motivated than BM participants. However, BM participants stated to be more motivated compared to the first week (*M*=4.66). Surprisingly, motivation question is the only question that BM participants were more positive (*M*=4.75) than the FB participants at the end (*M*=4.50).

Question 7: Does not keep me curios / keeps me curious about the data: In the early days, FB and BM participants were equally curious about the personal data (*M*: BM=5.50; FB=5.54). However, at the end of 4th week, the curiosity of both BM and FB participants decrease (*M*: BM=4.53; FB=5.06). When participants were asked to evaluate their overall experience about curiosity, FB participants stated to be more positive (M=5.15) than BM participants (M=4.53).

At the end, One-Way Anova analysis was run to understand if there is any significant difference between participants' final evaluations (Table 23) figured out that only significant difference was in evaluation of the aesthetics of the system ($F(1, 47) = 10.29$, $p<0.05$) with FB ratings increasing drastically. The results of communication of the system should also be listed as there is also significant difference between FB and BM participants ($F(1, 47) = 3.07$, $p<0.10$). No other statistically significant result was observed.

Table 23. One Way Anova Results of Survey Questions

ANOVA

		SS	df	MS	F	Sig.
Functions well	Between Groups	3.967	1	3.967	2.08	.156
	Within Groups	87.636	46	1.905		
	Total	91.604	47			
Makes me feel good	Between Groups	1.281	1	1.281	.74	.395
	Within Groups	79.851	46	1.736		
	Total	81.131	47			
Affects my social life positively	Between Groups	.827	1	.827	.68	.415
	Within Groups	56.114	46	1.220		
	Total	56.941	47			
Is aesthetically pleasing	Between Groups	18.278	1	18.278	10.29	.002
	Within Groups	81.689	46	1.776		
	Total	99.967	47			
Communicates with me well	Between Groups	5.254	1	5.254	3.07	.086
	Within Groups	78.726	46	1.711		
	Total	83.980	47			
Motivates me	Between Groups	.992	1	.992	.25	.623
	Within Groups	186.333	46	4.051		
	Total	187.325	47			
Keeps me curious about the data	Between Groups	1.892	1	1.892	.59	.445
	Within Groups	146.889	46	3.193		
	Total	148.781	47			
Is rich in terms of interaction	Between Groups	1.491	1	1.491	.79	.379
	Within Groups	86.816	46	1.887		
	Total	88.307	47			

6.3.4. USER ENGAGEMENT: IS/ IS NOT ENGAGING IN TERMS OF EXPERIENCE

In evaluation of engagement level, during the study, because of the limitations of the online survey tool, this question was asked with 5-points scale. These scores where later converted to Z-Score for making correlation analysis. Throughout 4 weeks, FB participants were more positive at the first week (M=2.87/5.00) compared to BM participants (M=2.11/5.00). While FB participants reported that they were less engaged compared to the first week (M=2.33/5.00) BM were slightly positive (M=2.17), but were still less engaged than FB participants. At the end of the study, FB participants reported that they had more engaging experience compared to BM participants (M: FB=5.25; BM=4.75).

All the correlation analysis was run to figure out the relations between the questions. To make the correlations appropriately, all "engaging" scores were transformed into Z-Scores as this question was asked to be rated in 5-score rating scale while final evaluation was on 7-score rating scale (See

Appendix J for correlations results). Results showed that engaging in terms of experience is strongly correlated with "functions well" (r=.47), "makes me feel good" (r=.76), "affects my social life positively" (r=.72), "communicates with me well" (r=.66), motivates me (r=.78), "keeps me curious about the data" (r=.63) and "rich in terms of interaction" (r=.70) (The table is listed in Appendix J). The only question that is not significantly correlated with engaging experience is "aesthetically pleasing question" (r=.17). Correlations results also show that "functions well" question and "affects my social life positively" are significantly correlated with all the rest of the questions. However, it is interesting that, apart from the "aesthetically pleasing" question, rest of the questions is significantly correlated with each other. Still, the correlation matrix gives valuable cues about what makes a personal informatics system "engaging".

6.4. **DISCUSSIONS**

This study has strong evidences in explaining the flow of engaging experience of personal informatics systems. This study has three major findings:

Role of *product centered factors* reveal that, engagement of personal informatics system in long term usage covers several product centered dimensions, such as usefulness, meaningful data/interactions, social experience.

Human centered factors affect the way the system is experienced; factors such as motivations, personal goals, activity levels and distractors are all influential of participant engagement.

Engagement can be inspirational factor of sustained usage and motivation; keeping people engaged with the system would ensure long term usage.

The study also showed potential points to keep people engaged with the systems. This is also required to have a holistic framework of making people keep benefit the system. The analysis of the survey and interview data highlights several key issues in understanding how engaging experience is comprised in personal informatics systems. These issues will be discusses in the following sections.

6.4.1. ROLE OF SYSTEM QUALITIES IN USER ENGAGEMENT

It was emerged that, people value functionality of the system in tracking activity and showing the number of calories burned. As was implied, the two top mentioned qualities of the system were related to the pragmatic qualities. This shows that, in order participants to have engaging experience with these systems, initial requirement is the function-related qualities: All usability and interaction problems should have been solved and the system should give the collected data in a way that every people can reach, understand and interpret easily.

Meaningfulness of data and interaction and usefulness of the data are the most system qualities of use engagement. The system was expected to give immediate access to data or rich interaction; otherwise, people lose their interest in the system. For instance, as stated in section 6.1.1, BM participants had problems in interacting with the system, which led to getting less benefit from the system. On the other hand, it was easy for FB participants to interact with the system by "one-click-only" type of reaching data. Still, the interaction with FB might be perceived as too simplified, as some of the FB participants defined the system as an extension of a "glorified pedometer".

"One-click-only" type of interaction was indicated to be a good way to access data, while BM system required synchronizing the device with either mobile phone or computer to access data visualizations. Thus, while FB participants were positive towards the system, BM participants responded negatively.

Aesthetics is another concern of people in assuring engaging experience. For instance, while BM participants were concerned about the size and portability of the device, FB participants were totally positive about the portability of the device. In particular, female BM participants were concerned about the appearance of the device, as it was visible to other people when they wear sleeveless tops and dresses. In contrast, FB was relatively invisible, as it is worn clipped to a pocket or waistband. These are also closely related to social experience as visibility of the device resulted in unexpected eyes of and conversations with other people in BM case.

Aesthetics actually is promoter of positive perceptions of engaging experience. For instance, one of the FitBit participants stated that "*it is still simple which can be beautiful*", which summarizes the overall concept of FB system. However, losing the device when exercised rigorously has been the concern of some FitBit. Thus, in terms of portability, both systems are desired to have the option of wearing the tracking device in a number of different ways.

The other mostly mentioned product centered factors have relations with each other:

- Ease of interaction and ease of communication with the system simplifies the way people interact with data which can strengthen the pleasure in use.
- The smartness level of the system can result in personalized interaction with the system.
- Comfort in mobility is closely related to visual qualities and pleasing aesthetics as size and weight of the device is the major concern of comfort in mobility. Size (and attractiveness of the device) also influences the social experience.
- Accuracy in the data measurement identifies the level of people's reliance on the system. It is another influential of usefulness and meaningfulness of data.

6.4.2. HUMAN-CENTERED RESULTS IN LONG TERM USAGE

Motivation and curiosity were the two human centered factors that participants talked about most. It was evident that, the system motivated some of the participants more than others and curiosity level of participants decreased after a while. At the beginning, most of the participants were positive about what the system represented about them. Increasing activity and losing weight made people feel positive about them and the effect of data visualization and feedback is deniable on these. In relation, feeling good was closely linked to curiosity and motivation to use the system. People need the systems to be prompted with suggestions to increase their activity, rather than just being notified about what had been done. It was observed that curiosity and motivation decline over time. This is partly due to the static information displayed by the system. People expect new generation personal informatics systems to be more adaptive and prompting.

Curiosity and motivation also indirectly support positive social experience. FB users can be more positive about discussing the product abilities with others, while BM users can be more frustrated as the device on the upper arm catches the attention of other people.

It was evident that, people realized how active/inactive they are or how healthy/unhealthy food they eat and became aware of themselves. Achieving initial goals with the assistance of the system, people would further use the system. Still, some distractors can impact getting the most benefit.

6.4.3. EVALUATION OF THE SYSTEM CHANGE IN LONG TERM USAGE

Results showed that, when people believe that a system in "helpful in reaching their goals" then they evaluate their experience higher and would like to keep using the system. In the current study, FB participants were mostly positive throughout the study while BM participants were relatively less positive. The evaluation results statistically illustrated that human centered and product centered factors are closely related with engaging experience. Even though people's motivation and curiosity decrease over time, they can still be consistent in evaluating function related dimensions of engaging experience. With all these evidences, it can be concluded that, user engagement and awareness can be sustained through system qualities usage. These will be discussed in the next section in detail.

6.4.4. ENGAGING EXPERIENCE AS INSPIRATIONAL OF SUSTAINED USAGE

Results of the study verify that, form and interaction factors of the system can intensify the desire to use and can sustain usage, by engaging people with observable positive outcomes. While many of these systems can be abandoned after a short time, and fail to help people realize their goals of becoming healthy or losing weight, findings of this study give insights about potential design implications to motivate people (1) to keep using the system and (2) change their behavior positively.

Results of the study also demonstrate that engaging experience can inspire people to keep using the system and sustain behavior. There are multiple reasons of why personal informatics systems cannot or cannot support use over time. These include maturing in awareness of behavior or after-effects of behavior. Several potential issues such as inability to track certain kinds of activity, already tracking certain activities with other products and services, or a belief that the data tracking is inaccurate can lead to abundance of the usage. As discussed, FB users were more positive than BM users about increased awareness of their behavior. It was because FB device has a small, easily obscured form factor and it assists easy access to data. On the other hand, BM users expressed their frustration and boredom with the system.

FB users felt more successful in achieving their initial goals. They looked at their data more, and reported more often that they were aware of increased activity and weight loss. On the other hand, BM users looked at their data less, and were not convinced that the system helped them to become aware of their behavior or to lose weight.

The study reports insights in user needs and expectations, and the reported evidences of user engagement can facilitate to draw "a model for explaining the engaging experience of system qualities that play role in the process of motivation and awareness physical activity" (Figure 44). In relation to the results, user engagement of this group of systems can be divided into four in relation to usage process.

1. *Willingness to use:* Generally, people have initial motivations and goals to use these kinds of systems. They either desire to lose weight, keep or increase their activity level and/or learn about their physical activity level (i.e. steps taken or calories burned in a day). When people do not have any of these initial goals, the success of the system will be susceptible. This means that when people lack expectations or needs in using these systems will not make sense for those. Having one or all of these goals can lead to start using a personal informatics system.

2. *Initial Benefits:* Second, when people start using the system, they expect the system to first satisfy their pragmatic needs with assuring expected benefits. Usefulness of the system and meaningful data and interactions play important role in doing this. If the system does not provide expected data, people doubt that the system is useful. In relation, if they feel that the system help them to jump start in reaching their initial goals, then people feel motivated to keep using the system. Otherwise, it becomes a barrier for people for that.

3. *Extended benefits*: After having cues to reach the initial goals, people expect more to justify keep using the system as their needs might change. At this stage, they consider the interaction and technology, as well as its visual qualities. Aesthetics is an important actor of perceptions: whether or not the actual device is visible to others affects the perceptions of social experience.

   People also start to expect the system to offer good interaction and communication both with the participant and with other parts of the system. Accuracy comes into prominence as they expect the system to "talk about the specific participant". Lack in accuracy of the data results in a barrier to keep using the system. This is because, people think that there is no sense to continue using a "useless" system.

   Feeling that the system is personal, people would like to avoid "compulsory" type of conversations with other people which is affected by the compactness (size and shape) of the device. On the other hand, some points of social experience might encourage people. For instance, when people feel the control of sharing their experience, they can use this aspect as a positive conversation starter with other people.

   Results support the fact that, all these listed system qualities are interconnected, and good system qualities reinforce the flow of engaging experience. These certify that, human-centered and product-centered qualities of systems assure flawless engaging experience, and the problems of usage and visual characteristics of the system should all be solved to maintain engaging experience.

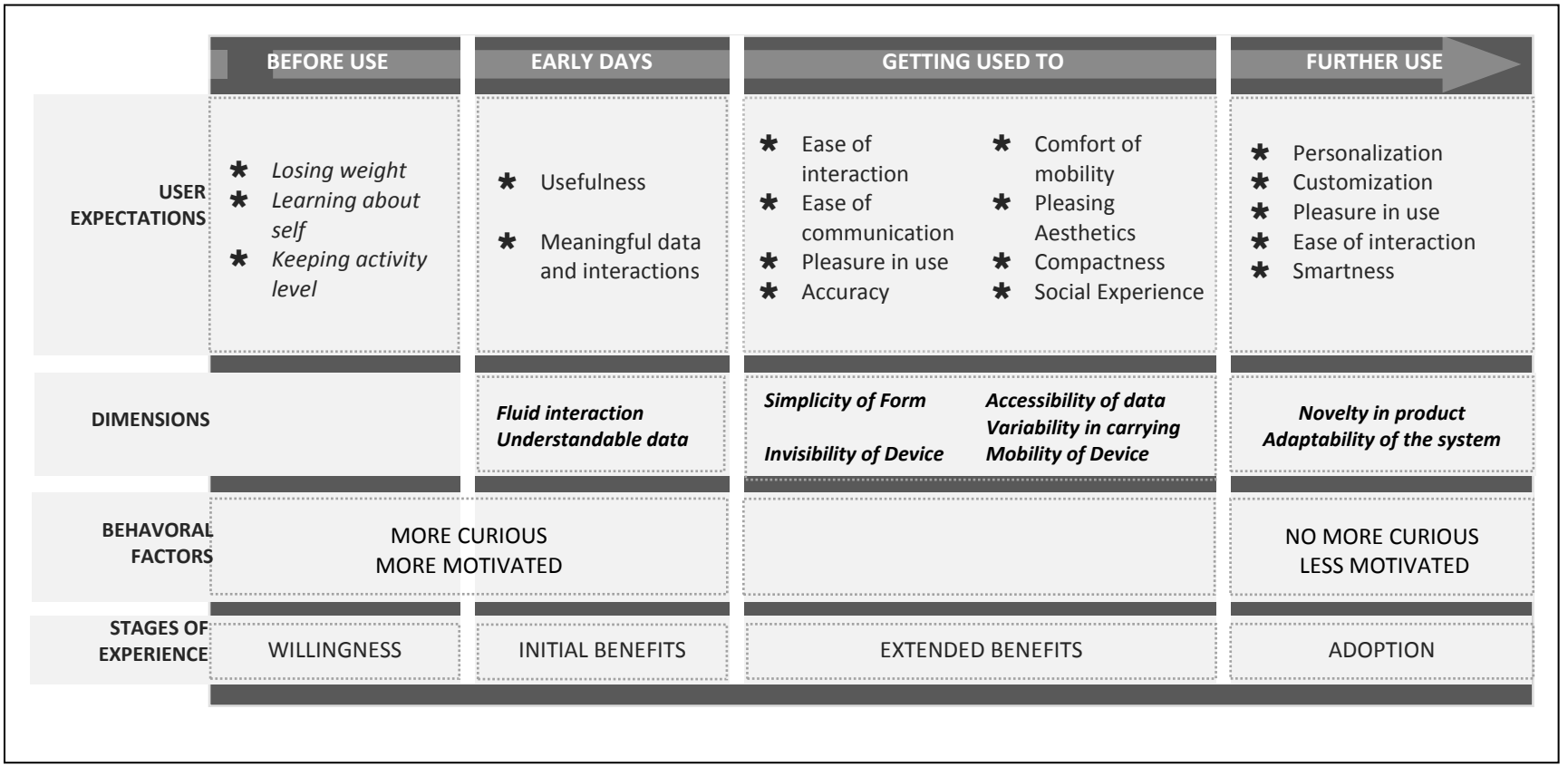

Figure 44. Flow of Participant Engagement of Personal Informatics System

4. *Adoption:* When people feel engaged with achieving their initial goals, they expect the system to offer more personal visualizations and prompts. Interaction, technology and aesthetics play important role in this, as personalization of data, easy interaction with the system and pleasure in use are the interaction-related expectations. These can be provided by making the system as smart as possible, by allowing customization and personalization of the system and data. All these are initial cues of people's expectations of "personal assistant" type of systems and interactions.

Today, people know that technology is developing fast and what seemed impossible in the past know comes true. In relation, they are aware of what future systems can and should offer. Therefore, with the listed findings, the question of how smart a product/system should be to offer engaging experience to persuade people was also answered. The use of personal informatics systems is on the rise, tracking data about physical activity for those who would like to become more active or lose a few pounds. Yet many of these systems are abandoned after a short time, and fail to help people realize their goals of becoming healthy or losing weight.

With this study, it was expected to understand how the design of a personal informatics system might offer an engaging experience and therefore inspire long-term use. In this chapter, a five week study was presented comparing the experience of using a BM armband or a FB activity tracker to track physical activity and calories burned. It was learned that user engagement with the system has several dimensions, including easy access to data, feeling good about the self in product use, and positive social outcomes support engaging experience. User engagement can also be sustained in long term product use, and offer the potential to change human behavior.

Drawing from these findings, design implications for future personal informatics systems that can support awareness and motivation for positive behavior change, the models presented in Chapter5 and 6 will be discussed in detail in the next chapter with conclusions and future implications.

CHAPTER 7

CONCLUSIONS

This thesis scrutinizes the experience of personal informatics systems and colligates the notions of experience, persuasiveness and technology that have been elaborated in design literature recently.

In the literature, it has been endorsed that experience of smart and mobile technologies can make people's life easier. Thus, those can be designed so as to change behavior for having a healthier life. Focusing on physical activity, it is now possible to track people's activities, give feedback and motivate them to keep or improve their exercise behaviors. On the other hand, user experience has become the major underpinning of design. By exploring the interaction between technology and people, user experience literature serves basically for improving the living standards of people through technology. Thus, focusing on different types of interactive products and systems, user experience literature puts forward several models to define the dimensions of experience and methods to design "for" experience. In all of them, whatever the method is, it is obvious that understanding user experience requires direct observation to design for it. By internalizing the relevant literature and discussions, this thesis endeavors to answer the research questions specified for experience of personal informatics systems. This chapter recapitulates the contributions made by the studies and the models presented in the thesis.

7.1. CONTRIBUTIONS OF THE THESIS

The major contribution of this thesis is in defining the level of importance of the user needs and expectations in relation to their experience with personal informatics systems; in exploring people's experience of system qualities; in determining the relations between system qualities in long-term experience and in understanding the factors that affect sustained usage in the long run. This thesis also emphasizes the importance of user engagement in experience of personal informatics systems. With a detailed explanation of dimensions of user engagement, this thesis contributes to the design of similar systems that would lead to behavior change by creating self-awareness.

By doing these, this dissertation has demonstrated the following:

- It demonstrated the evidence that people's early experience reveal the factors that lead to unwillingness to use the system.
- It demonstrated the evidence that keeping people engaged with the system is the key indicator of sustained motivation and usage.
- It determined that people's early experience put forward people's expectations from these types of systems.
- It introduced the model of relations in early experience of personal informatics systems.
- It described the qualities that play role in engagement of personal informatics system in long term usage
- It introduced the model of relations for engagement of personal informatics systems
- It proposed key qualities that should be considered while designing new personal informatics systems to sustain engagement and enrich user experience

7.2. RESEARCH QUESTIONS

As it was stated in the Introduction, the scope of the thesis is as follows:

> *"explore the dimensions of user experience of personal informatics systems, and put forward a model of relations for people to engage with these systems."*

While defining the problem, it was stated that observing hands on experience of users is required to understand the user experience. Therefore, both studies explore user experience through hands on experience. In order to understand user experience in detail, two main questions were tried to be answered:

QUESTION1
What are the dimensions of early experience of personal informatics systems?

In Study1, exploring the data with qualitative and quantitative analysis enabled understanding the reasons behind people's evaluations and expectations. Relations that are pointed out in Chapter5 helped to understand the early drivers of user experience of personal informatics systems which were observed as human centered factors such as people's initial goals and activity levels, as well as product centered factors such as system's ability to measure data accurately. In relation, initial goals, expectations, system qualities, system characteristics and time can be listed as the major influential of early user experience.

Effect of Initial goal: To start using such systems, people have initial goals to use the system (Figure 45). These systems are used for a "specific purpose". It is especially crucial for these kind of systems to match people's purposes, as they just don't serve for a function, but has an aim of creating self-awareness and changing behavior positively. Therefore, experience of the user changes with the effect of initial goals.

User expectations*:* People's initial goals affect the qualities that people expect from these systems. When the initial goal is just to learn about self then people expect more "useful data" about self; when the initial goals is to become more active, then people expect smart and instant feedback and suggestions from the system. In relation, not being able to get the expected data, people start to lose their interest in the system. These are the simple indicators of how people's needs and expectations can change as people get to know the abilities and possibilities of the systems.

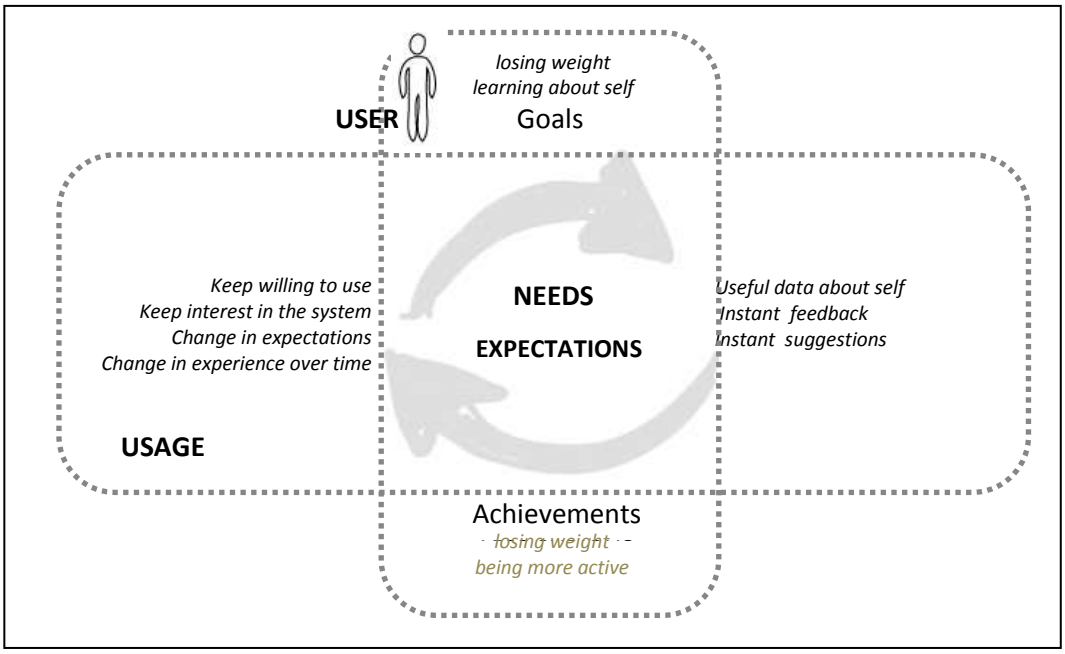

Figure 45. Dynamics of a Personal Informatics System Usage- I

Effect of System Design: System characteristics which were grouped as usage, visual, interaction and product- body relation play role in positive experience of these systems. The dimensions that form these characteristics have relations with each other and thus during experience they should endorse each other. In a broader sense, experiencing a problem in one of the qualities affect the experience of others and it reduces the positive effect of the system.

The details of user experience cover several associations with properties of the system. The critical point is that, people identify these properties with what they perceive about and use the system. It becomes hard to devote one property to one quality; rather all are linked up to the chain of experiences. In addition, when people talk about a quality, it is hard to distinguish whether it is a product or system specific property, because all the qualities are nested in one another. Therefore, designers should not ignore the detailed evidences of experience provided in Chapter5, but try to understand those as a part of the holistic picture of experience (Figure 45). To draw this picture, in Chapter5, the qualities that affect positive experience were listed. These qualities also inherit the cues of why people would be willing to use a system. Understanding the qualities that prevent abundance of system will affect the success of these systems in the long run.

Effect of time: From a broader perspective, the influential and dimensions of experience is originated in the nature of the dynamism in it. There are static system qualities such as pleasing aesthetics or expressiveness, that users cannot change easily; but there are also dynamic qualities such as interactivity and usefulness that users expect adaptation from the system. In fact, the dynamism in experience of personal informatics systems stems from the dynamism of "data presented". The data presented changes every time when the user "moves". Rather than using the system at specific places and times, users need to carry the parts of the system everywhere, which leads the user to experience different kinds of case specific conditions. In relation, to make the system acceptable, designers should assure that users would be enthusiastic to carry the system everywhere. In social environments, a misinterpretation of the system by other people affects the way the user appreciation of the system negatively. Thus, it is possible to state that making the portable parts of the system invisible when not used affects people's lives positively.

At the end of the first study, it was evident that, although people were enthusiastic at the beginning, none of them wanted to keep using the system and this emerged as an important issue to be explored in detail. The major issue in understanding experience of personal informatics systems was that as

people's expectations and experience change over time, these systems should be able to generate responses and instant feedbacks as a response to these changes. However, how experience of people change over time couldn't be explored in the first study. Specifically, finding system qualities that would engage users to sustain usage with the system emerged as the critical point in sustaining usage and getting the most benefit from them. Thus, the dimensions of engaging people with these systems to sustain system usage and prolong user experience were explored in Study2.

QUESTION2

What are the dimensions of user engagement to sustain usage of these systems?
In long term usage, it was observed that to keep people engaged with the system, both system and user centered factors come into prominence equally. While people's experience depends on system related qualities, as part of nature of user experience, it is also affected by personal factors such as motivations or distractors of daily life (Figure 46). In fact, the evidences of time effect were blurry understood in the first study, but these become more evident with the results of the second study. It is because, during 5-weeks-long study, people were able to experience the system in several different conditions. The result of the study showed a similar pattern with the *first study, initial goals, expectations, system qualities, system characteristics and time* are also listed as the major influential of early user experience. In addition to those, flexibility in system characteristics, flexibility and personalization of system parts and smartness of the system emerge as the verifier of engaging experience.

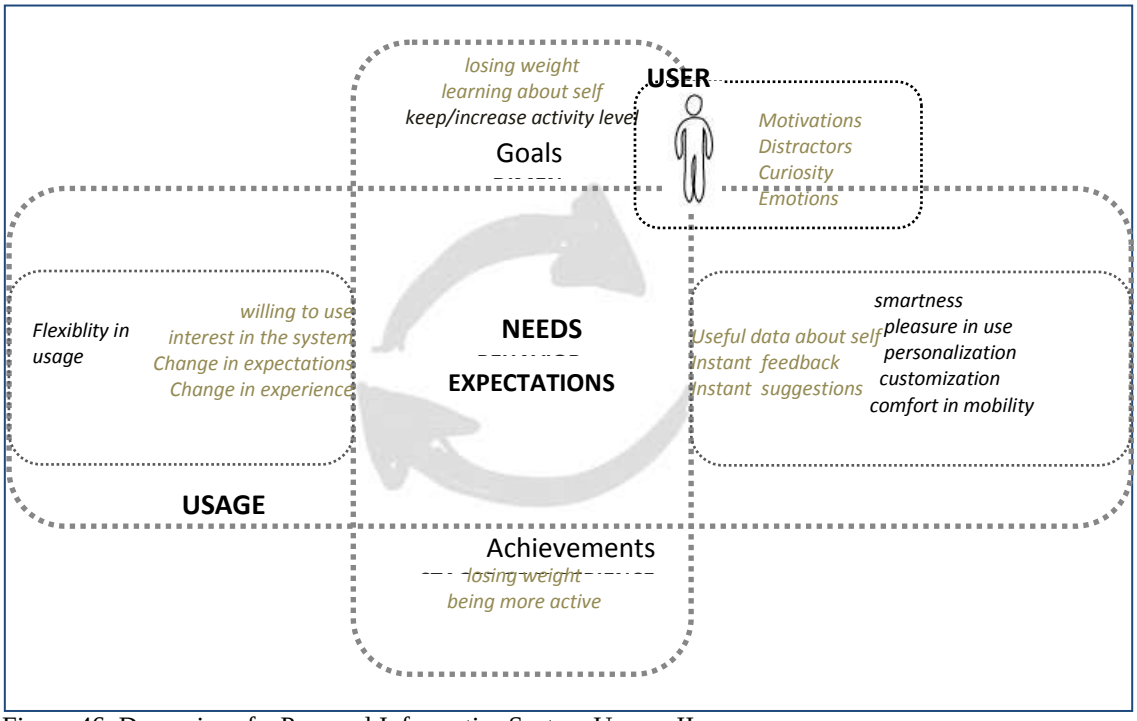

Figure 46. Dynamics of a Personal Informatics System Usage -II

Effect of flexibility: Flexibility of the system parts is required for satisfying several user needs and expectations of both usage and aesthetics. For instance, flexibility is good way of satisfying people's pleasure in use and comfort in mobility expectations. It can enable customization of system parts such as changing the location of data presented on online system. Getting instant data and feedback are the most critical flexible interaction expectations. Flexibility in usage is mostly related to usability of people's way of reaching data: people do not want to be forced to a single way of using the system,

but expect various ways to be able to utilize the system. Also, flexibility in aesthetics is fed by and affects the flexibility of usage and interaction. People expect the mobile parts of the system to have flexible aesthetics, so that they can put the mobile parts on different parts of the body. This is quite related to flexibility in usage, as it also gives the ability to hide it whenever needed. People also expect flexibility in visualization of the online system which is highly related to the flexibility in interaction.

Effect of personalization: Through personalization of mobile parts of the system, the system will adapt itself to people's expectations and changing conditions. Similarly, personalization in data works like a motivational factor of system use: when the data and the suggestions coming from the system can be personalized, then the user feels more dependent on the system in learning about self. To achieve all these and keeping people's usage and interaction alive all the time, the system should provide smartness in concrete grounds by giving personalized feedbacks and suggestions by analyzing existing user data.

Effect of smartness: Smartness of the system will strengthen the dependence on the system when it could realize changes in users' daily routine (i.e., not being active for 4 hours unlike other days). By giving motivative, but not disturbing, messages, system can have the ability to keep user engaged with the system at abrupt situations. Otherwise, the interest in the system will wear off, and users will intent to abandon system. The results emphasize the importance of smartness in user engagement of personal informatics systems. Even though it was not in the list of highly mentioned system qualities, it is obvious that having smart attributes, the system can elevate user engagement by strengthening the experience of other system qualities.

Thinking that people are social beings, user experience and engagement cannot be investigated by allocating people from social environments. Visual characteristics of mobile products bear special significance as the product becomes a way to express its user in social environments. Mobile parts of personal informatics systems are required to provide positive impact on both users and other people around users. It is because, users are affected by other people's opinions and their perceptions and obviously negative affect results in decrease in interest and thus engagement.

7.3. COMPARISON OF THE STUDIES

Even though the studies were conducted in different countries, the general idea about and expectation from the systems were similar: people expect smart, motivative and personalizable qualities from the systems in addition to useful, interactive and pleasing characteristics. These two supplementary studies help to form the dimensions of user experience of personal informatics systems in detail. Both studies showed, in a broad sense, human centered and product centered factors are integral parts of user experience of these systems.

Results of "Stages of Change" in both studies indicated a slight change, which actually showed a tendency to change, in behaviors of some of the participants. As stated, the aim of the studies was not to create behavior change. However, change in behavior was observed for a limited number of people's behavior. Still, indications of behavior change cannot totally be associated with system usage as there are other personal factors that can affect people's behavior.

7.4. DESIGN IMPLICATIONS

This thesis provided knowledge by creating models of relations in early user experience and user engagement of personal informatics systems. Future designers can utilize these models to in several ways. As discussed above, user experience is dynamic and designers cannot "design experience", but can design "for" experience. Every product design is case-based, and designers need knowledge of circumstances of case specific product use and its users. In accordance with these, current thesis puts forward the dynamics of user experience of "personal informatics systems" case, and how people can be motivated through these systems. Therefore, the findings listed in this thesis are not certain

deliverance that designers must accomplish, rather, the findings can be conceived as suggestions and knowledge for designers.

Designers of future personal informatics systems will need concrete suggestions for future systems. In the following lines, the requirements that need special elaboration in motivating people to be active and to keep using the system will be discussed through "why, what and how" questions of Hassenzahl (2011). It is well-known that the basic functions like, measuring steps taken or calculating calories burned are the inherent functions of these systems. Taking those for granted, designers are in need of requirements that will make these systems successful in reaching people's goals.

To guide designers, *interactivity, connectivity, personalization, understandability, flexibility, appropriateness, invisibility and expressiveness* of the system are predicted to be critical for design of future systems. These will be discussed under two groups: information related and product related requirements (Figure 47). Both information and product requirements have relations with each other, therefore these cannot be isolated from one another. As a starting point, all these can be obtained through the abilities of adaptive technology, smart features and context aware features.

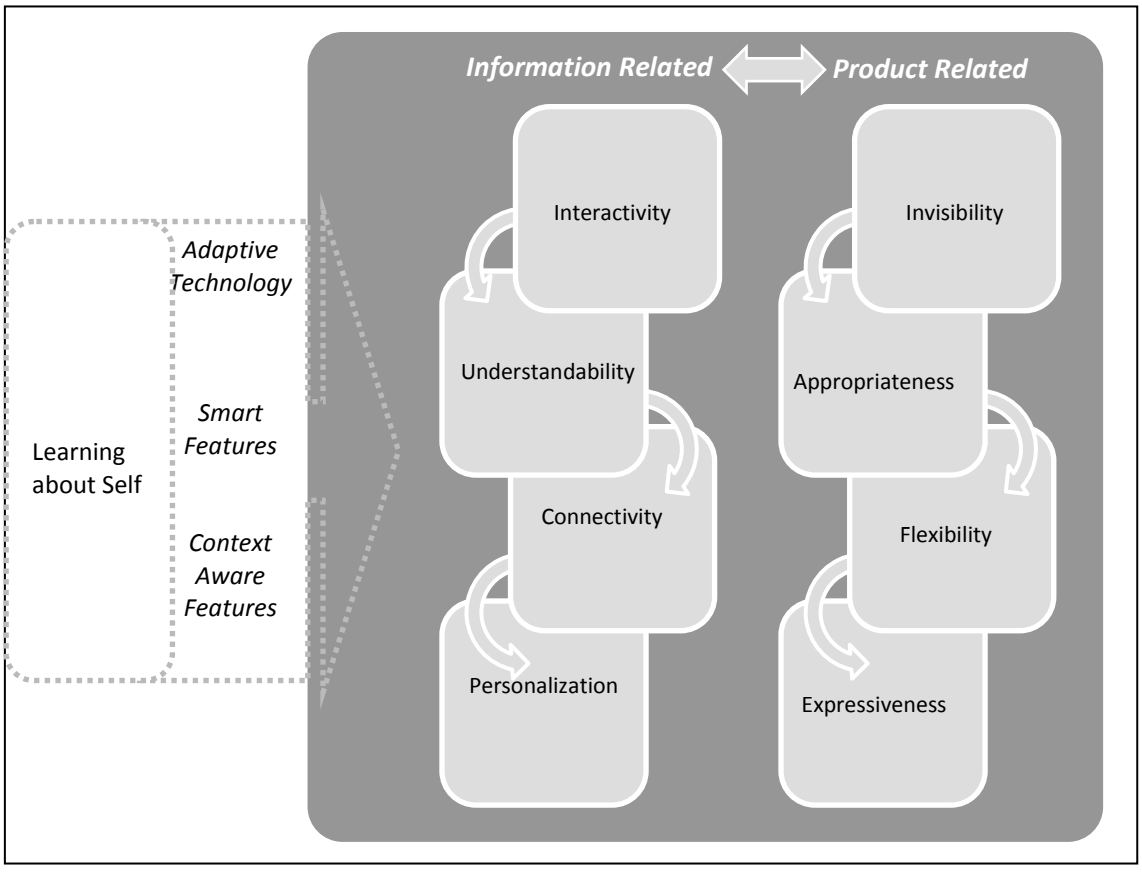

Figure 47. Design Requirements

7.4.1. INFORMATION RELATED IMPLICATIONS

As stated, in terms of information related requirements, *interactivity, understandability, connectivity, and personalization* are the important and interconnected ones. It is possible to state that interactivity and understandability of data are requirements for success of early experience, and designers should ensure connectivity and personalization for further user engagement. However, it should be

remembered that lack of satisfying interactivity and understandability requirements in early experience can lead to disengagement at early stages of experience (Figure 52)

most important function of personal informatics systems is *collecting personal data*, therefore the listed requirements should be provided to satisfy this major need in seamlessly.

Interactivity

- **Why it is important?** It is the *key verifier of learning personal data* as it defines *how the data should be delivered.* (Figure 48)
- **What is expected?** People expect to learning about self through *fluid interaction* with data to be engaged with the system. In addition, ease of access to data becomes good motivator for keeping self under control.

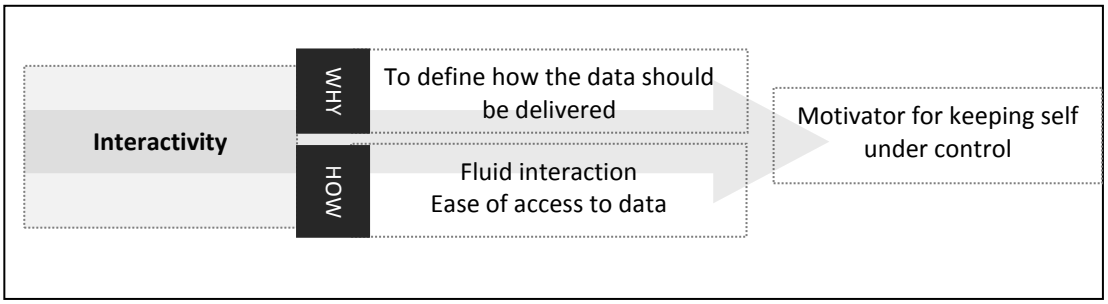

Figure 48. Overview of Interactivity

- **How could it be achieved?** Interaction with data is required to be straightforward, but it is also required to provide information in a way that clearly shows improvement and progress towards a goal. Clear visualization of personal data can also strengthen interactivity of data, as for people visual representation is better to understand than just numbers. In this sense, interactivity has connection to understandability of data. Interaction with the data should be clear and should yield easy steps to reach data. In addition, the system should give incentive and fun messages to strengthen interactivity.

Understandability

- **Why it is important?** It is about *how the data tells about self.* Understandability is interconnected to interactivity as combination of these can serve for making it *easy to understand* what the data tells. (Figure 49)
- **What is expected?** Learning about self through *understandable data* is required in order to help people realize *their personal data efficiently.* Like ease of access, *ease of understanding the data* becomes good motivator for keeping self under control.

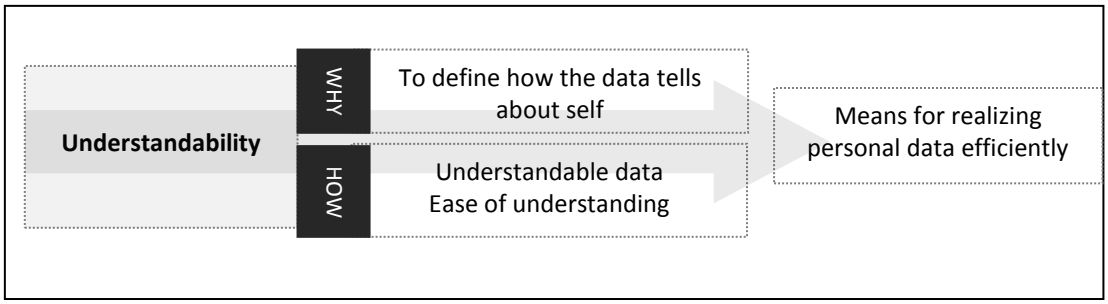

Figure 49. Overview of Understandability

- **How could it be achieved?** To make the data understandable, first the system should give meaningful data; it should be clear in terms of both visual and verbal presentation. The graphs and the information the system gives could have expressive characteristics. Those can be represented with analogies that people can easily interpret. Understanding what numbers (of steps or calories burned) should also be clearly implied. For verbal presentation, if possible, the presentation of data should be in native language of the user; if not, in order to make the data understandable by all people, it should be visualized and the verbal data should be limited to minimum. To achieve this, the number of ways to explain data could be increased, and both the portable part and online part of the system could have the same visual data language.

Connectivity

- **Why it is important?:** Connectivity is important as being connected to the system whenever desired is required so as to enable *making meaningful interpretations about self.* In addition, it strengthens the accountability to be active.
- **What is expected?:** *Keeping connected to the system* whenever the user is expected to engage people with the system, as instant access to data increases the *availability of data*.

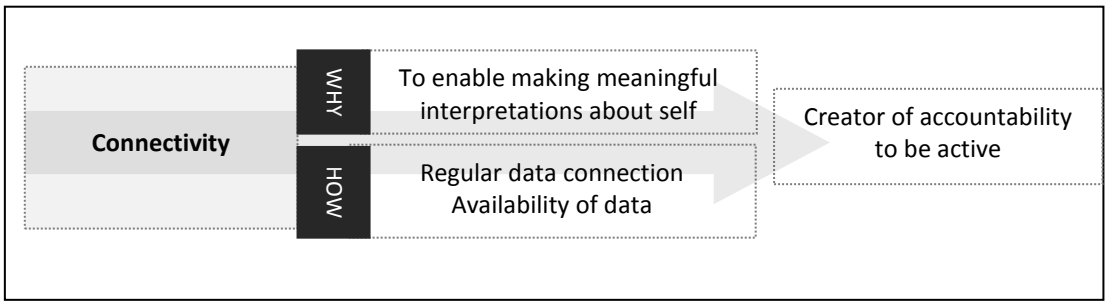

Figure 50. Overview of Connectivity

- **How could it be achieved?** Through adaptive technology, instant data access should be ensured to enable users analyze their personal data immediately, and take instant steps to overcome the unexpected results. For instance, checking data instantly and seeing the number of steps taken in a day can result in taking more steps in the rest of the day. The system should not force the user to connect the portable device of the system to be connected to the computer to reach data; rather there should be easy ways to get connected to the data, such as through the display of the device or mobile application. In relation, the portable device should communicate with other parts of the system or even other systems practically, to facilitate fluid connectivity. Accessibility of data

through several media from everywhere is also critical, in order to make the data access less complicated to be accessed.

Personalization

- **Why it is important?** Personalization of data and feedback makes the user feel that the system is "talking about" him/her personally, which strengthens the feeling of "*ownership*" of the system. (Figure 51)
- **What is expected?** By understanding the specific user, the system is required to *adopt* itself to user requirements by understanding the context of use.

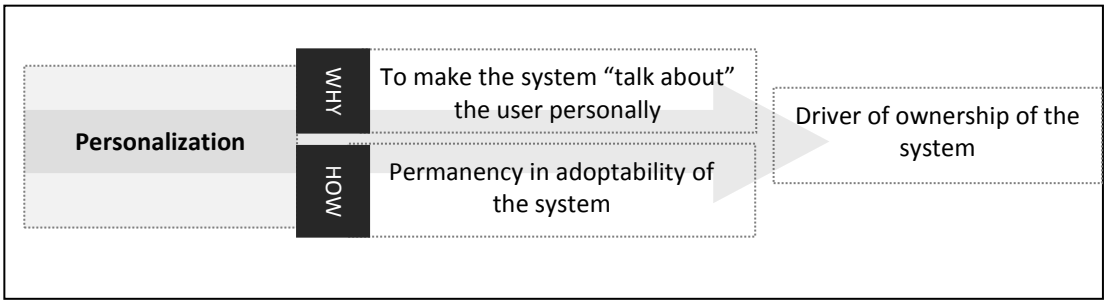

Figure 51. Overview of Personalization

- **How could it be achieved?** Through smart features, the system should analyze the data and make suggestions accordingly. Future systems could go beyond the simple display of information to include personalized prompts for individual users or case-specific solutions. The system should represent a person's ideal self in terms of who they want to be, satisfy them emotionally, and prevent them from becoming bored of usage. For example, future systems could support uploading self-imagery that might change automatically over time as goals are reached, or offer encouraging sounds and reminders if routine system use is suspended. In addition, "being tailored" to the user should be regarded as a transition to a "personal coach", in which the system should encourage the user with personalized messages to improve the well-being. Similarly, the system should personalize the goals of the user in relation to the state of the user. For instance, the goals can be changed to reach an upper level if the user is doing well in reaching initial goals. In relation, increasing adaptability of the system to changing user context, such as changing time and environment so as to keep user engaged.

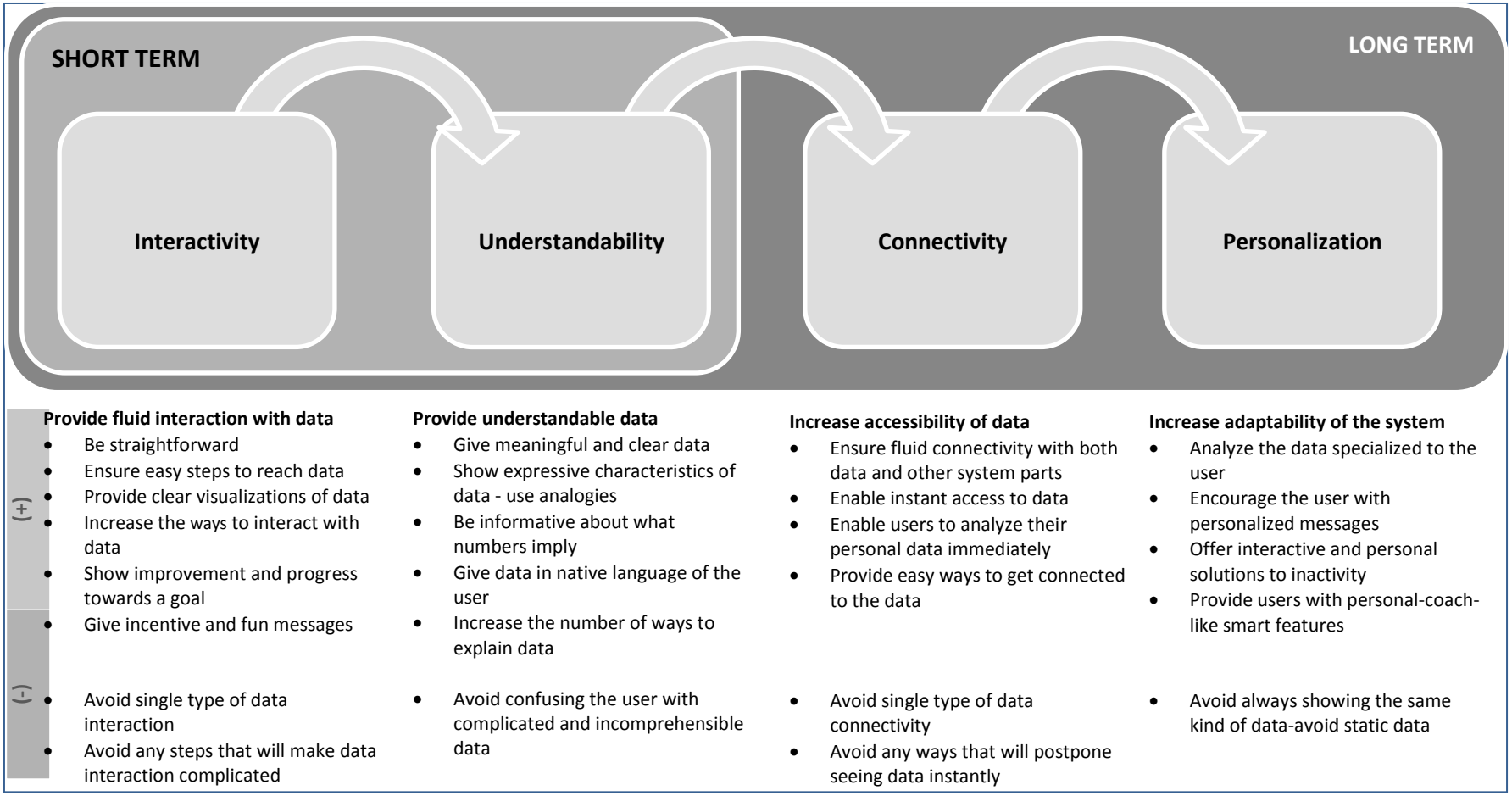

Figure 52. Information Related Implications

7.4.2. PRODUCT RELATED IMPLICATIONS

As stated, in terms of product related requirements, appropriateness, invisibility, flexibility and expressiveness are the important and interconnected ones. It is possible to state that visibility and appropriateness are important requirements for success in early experience, while designers should ensure flexibility and visual language for further user engagement. Still, lack of satisfying visibility and appropriateness requirements in early experience can lead to disengagement at early stages of experience (Figure 57).

Appropriateness

- **Why it is important?** The portable part of the personal informatics system is the main ubiquitous data collector of the system. Therefore, appropriateness of size and weight is important to make the *product easy to carry on the body* (Figure 53)
- **What is expected?** It is expected that the size of the portable part of the system be small in size, and light in weight, in order to increase the *mobility of it.*

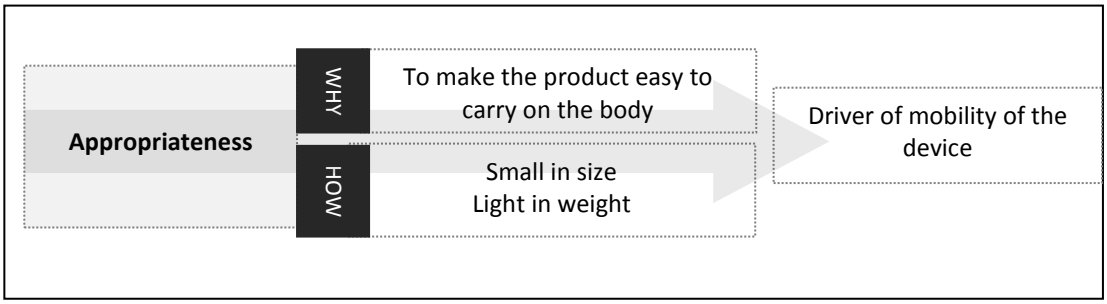

Figure 53. Overview of Appropriateness

- **How could it be achieved?** First and the most important, the device should have appropriate size and weight, if possible be small in size and should be lightweight. This will ensure the user forget about its presence and be able to make it a natural part of life. To do this, designers can make analogies with other types of products that are carried on people, such as wrist watches. It will be a simple way of assuring comfortable ways of carrying in terms of size. Being big in size makes tough to carry on the body, therefore compactness of the device will also make it compatible with the body. However, while making it small in size, designers should find avoid it from being lost.

Invisibility

- **Why it is important?** Invisibility in form and usage is important to *maintain people's privacy* towards the society. It is required to keep people control over sharing their experience (Figure 54).
- **What is expected?** Keeping the product *unperceivable by others*, it is expected that the product could keep *simplicity of form* in order not to catch attention.

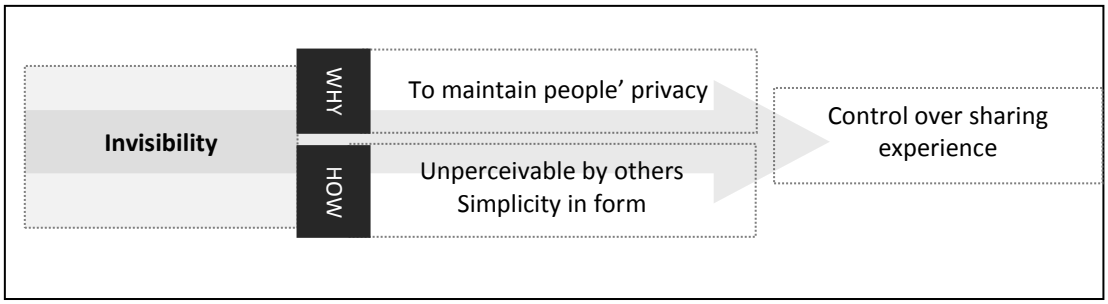

Figure 54. Overview of Invisibility

- **How could it be achieved?** Invisibility is closely related to appropriateness; therefore, in addition to providing the requirements of appropriateness, the portable part of the system should be unrecognizable by others to avoid the user from being asked about it unexpectedly. People should share their experience only if they want, therefore, size and location of carrying device should supply this; it should not catch other people's attention. The device should not be obvious and intruding and perceived by others. To ensure this, as stated, the size of the device holds high importance, as people shouldn't be led to ways to hide it; being hidden should be inherent.

Flexibility

- **Why it is important?** Flexibility in carrying is required to *provide variability in carrying*, and it gives the user ability to change the place of the portable device on the body.
- **What is expected?** Providing flexibility in usage, the product should *increase the number of ways and types of carrying* the device.

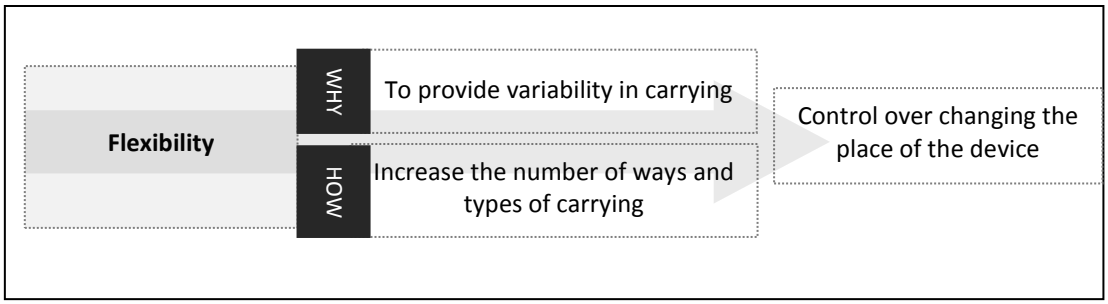

Figure 55. Overview of Flexibility

- **How could it be achieved**? As a starting point, designers should make it flexible in terms of portability as flexibility can also strengthen the invisibility of the portable part. In relation, designers should provide versatile ways of carrying, especially on different parts of the body. To empower the flexibility, the user should be provided with suitable ways of attaching the device to body or clothes. For instances, provide flexibility in carrying such as clipping on clothes or wearing on wrist can be a good solution. If it needs to touch skin, designers need to explore ways of carrying on different ways, but users should not be forced a single type of carrying.

Expressiveness

- **Why it is important**? Expressiveness is required to maintain user engagement as in addition to all the previously listed ones, it helps to *provide positive social experience*. It is also important to prevent people from getting bored of carrying it over time (Figure 56).
- **What is expected?** Visual language of the system is expected to yield the main purpose of these systems, *improving personal well-being* and therefore *representing* this purpose through *different and new product language* is expected in the design of these systems.

Figure 56. Overview of Expressiveness

- **How could it be achieved?** Through the visual properties, the portable part of the system should be differentiated from other medical products, such as blood pressure monitoring devices. This can be ensured by providing good visual characteristics so that those can make the user feel good about carrying the device. In addition to expressive requirements, form, size and color of the device could also enable users to express themselves, which can sustain usage in the long run.

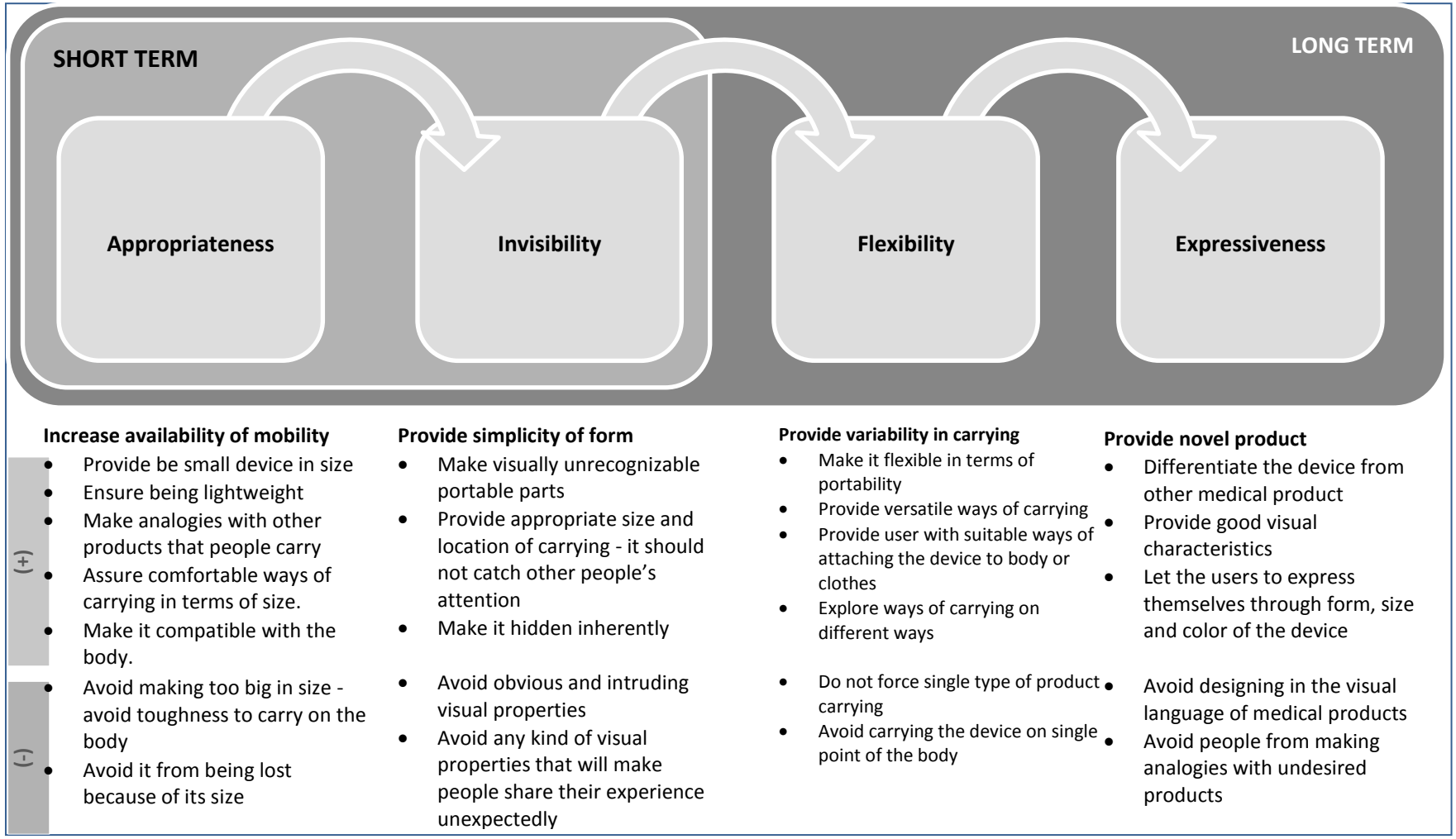

Figure 57. Product Related Implications

7.5. LIMITATIONS OF THE STUDY

In first and second study, there were a number of limitations that future researchers should take into consideration. These can be listed as follows.

Even though the Stages of Change Scale informs the researchers about the physical activity levels of participants, the results of this scale did not give significant information about people's behavior change in the current thesis. That was because, the length of both the first and second study was not long enough to understand the change in physical activity levels of participants. Besides, even though the results of the scale indicated that some of the participants changed behavior, it couldn't be argued that this change resulted from the system usage.

During the second study, everyday participants were asked to fill an online survey. It was observed that, after a while, some of the participants dropped to fill the survey in detail. Therefore, when applying similar methodology, weekly surveys which concentrates on key factors that affected users' experience throughout the week can be preferred. This will probably prevent the participants from dropping out of the study.

In relation to the previous limitation, using the dairy method by using the daily reconstruction method was not efficient enough to understand the flow of user experience in a single day. For the future studies, conducting face-to-face interviews at the middle of the usage process and retrieving information about participants experience until that time can be more efficient,

7.6. SUGGESTIONS FOR FURTHER STUDIES

While personal informatics systems give information about self, they also educate people about themselves. Once people get that information, they use it to improve or change their behavior in certain ways. The person will not be the same person before and after using that information. The results of this thesis showed that people can feel enthusiasm to keep using the system or totally abandon usage. However, the success of such systems is in twofold: making people engaged with the system and making people change their behavior. Thus, this process is a flux of actions. That is because; it is hard to make discrete research for these kinds of systems. Still, the listed can make future designers more strong in designing future personal informatics systems.

First, it was observed that, social experience of people affect their praise in these systems. In addition, social media has strong influence in sharing people's ideas as well as their achievements and failures. The influence of sharing experience through online systems within a special group of users can contribute to the design of holistic personal informatics systems.

Second, the mobile phone application selected for the Study2 was not successful at all in engaging people. However, it is well known that mobile applications are becoming widespread as people started using smartphones. It can be a good research to understand the effect of mobile-smart applications on behavior change.

Thirdly, how experience is affected when people have the capability to change the system by entering data into the system that directly affects the system can be explored. Personal informatics is a new area that brings many disciplines, interaction, service, industrial, systems, of design together. The intersection of these fields covers challenging questions that will lead designers. This makes it hard to satisfactorily answer the user needs since, as much as experience of these systems, the data that people are entering into the system makes the system is very dynamic. Therefore, it could be a good research topic for future designers.

Finally, in order to understand the success of people's behavior change through these systems, a controlled study can be conducted to understand the effect of these systems for at least 1-year, which can be conducted as a follow-up study of the Study2. The researchers can utilize the model presented in Chapter6 for constructing the further research. This research can also explore the aspects of user engagement over time.

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APPENDIX A:

OVERVIEW OF REVIEWED LITERATURE-MAIN ARGUMENTS AND RELATED THEORIES

This appendix includes review of psychology literature.

Table 24. Literature Review of Psychology Literature

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
Balance	Attitudes Attitude change	→ There are two types of relationships between the people's attitudes towards other things/people and a third object/person: Balanced: Odd number of (+)s between subjects Imbalanced: Odd number of (-)s between subjects → Imbalance is motivational: imbalance causes restoration of balance among the subjects/elements →People need to maintain balance to be comfortable about the situation.	Imbalance in attitudes → restore the balance	The theory cannot handle more than 3 ideas at once.	(Heider, 1944, 1958) Also in (Benoit & Benoit, 2008; Fiske, 2004; Petty & Cacioppo, 1996)	*Congruity *Attribution
Congruity	Attitudes Attitude change	→ Quantify the relations in Balance Theory with a formula to predict attitude change. →Theory makes specific predictions on the direction and amount of change →The theory predicts that more polarized attitudes will change less than moderate attitudes. → Why some messages are ineffective is explained. →Theory classifies the messages as associative or dissociative, not take the strength of the messages into account.	Incongruity →reduce the incongruity	Not all attitudes are equally important. Ignores message content.	(Osgood et al., 1957; Osgood & Tannenbaum, 1955) Also in (Benoit & Benoit, 2008; Petty & Cacioppo, 1996)	*Balance *Cognitive Dissonance
Cognitive Dissonance	Cognitions Attitudes Attitude	→Defines 3 relations among cognitions: Consonance: consistent 2 ideas Dissonance: inconsistent 2 ideas	Dissonance → reduce the dissonance	Theory explains the proportion of dissonant and	(Festinger, 1957) Also in (Benoit & Benoit, 2008;	*Balance *Congruity

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
	change	Irrelevance: irrelevant ideas →Magnitude of dissonance affects the decisions to change an attitude →People restore consonance by: Changing cognition Adding new cognition Change the importance of the cognitions →People may chose an alternative within alternative attitudes to reduce the dissonance		consonant cognitions Importance of the cognitions is also taken into account.	"Cognitive Dissonance Theory," 2010; Cooper, 2007; Fiske, 2004; Perloff, 2010; Petty & Cacioppo, 1996)	
Social Judgment /Involvement	Attitudes Attitude change	→People judge the messages coming from a persuasive message and the amount of involvement in the message affects the acceptance/rejection →The judgments of the message, where the message falls compared to their own attitudes determine the agreement/disagreement with the message. →Three concepts regarding the personal attitudes are important: latitude of acceptance/rejection and non-commitment →High involvement in the attitude creates a larger latitude of rejection	Through judgments of the messages	Theory is not clear on the process of change	(C. Sherif, Sherif, & Nebergall, 1965; M. Sherif & Hovland, 1961) Also in (Benoit & Benoit, 2008; Perloff, 2010; Petty & Cacioppo, 1996)	*Elaboration Likelihood
Elaboration Likelihood	Attitudes Motivations Attitude change	→Motivation and processing ability of the person is the determinant of attitude change. →Two routes to change: central (mostly related to the person) and peripheral (mostly related to the message) →There is a "message" to be processed, and this message persuades the person to change	With high motivation and involvement in the content of the message	Explain the phases of attitude change	(Petty & Cacioppo, 1986; Petty et al., 1995) Also in (Benoit & Benoit, 2008; "Elaboration Likelihood Model,"	*Social Judgment /Involvement

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
Table 24. Cont'		the attitude. →Content of the message is important for persuasion. If the message is not understood, it cannot persuade. →More enduring attitude changes are resulted from personal involvement and motivation to take the issue or argument into account			2010; Fiske, 2004)	
Attribution	Attitudes Motivations Causes of behavior	→Main concern is how people interpret the events and the relationship between these interpretations and behavior →People think about the "why" questions and the causes of behavior →People make 2 kinds of attributions about the events: Internal: attributions resulted from and related to attitudes and personality External: attributions resulted from the events/things that the person is experiencing → Each person can an influencial of internal (personal) and external (environmental) attributions. →Motivation significantly affects the attributions: it affects how the person perceives the task difficulty, chance of success and behavioral outcomes.	Through causal cognitions and motivation	Widely used to understand the reasons of accepted and rejected behaviors	(Heider, 1958; Jones, 1972) Also in ("Attribution Theory," 2010; Försterling, 2001; Graham & Folkes, 1990; Petty & Cacioppo, 1996; Weiner, 1985)	*Expectancy x Value
Social Learning	Learning Behaviors Motivations	→People learn from the behaviors of others, by observing and modeling →Behavior is explained through interactions	By learning behaviors	Theory later named and turned into Social Cognitive	(Bandura, 1977b) Also in ("Social Learning	*Self efficacy *Social

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
		between cognitions, behaviors and environment. This interaction is reciprocal. →How behaviors are modeled: Attention to learning a behavior Retention recalling the learned behavior/what the attention was on Reproduction of the learned behavior Motivation to reproduce what behavior is learned		Theory	Theory ", 2008)	Cognitive
Self Efficacy	Behavior Behavior Change Self efficacy Motivation	→There are 4 main sources of self efficacy: Mastery experiences: Related to hardness of the experience Vicarious experiences: Provided by social models. Social persuasion: Verbal persuasion of other people Physiological and emotional states: Interpretation of stress reactions and tension/reliance of self for judging the capabilities. →Efficacy activates 4 main processes: Cognitive process: Thought. Motivational process: Self beliefs of efficacy→self-regulation of motivation. Affective process: People's beliefs in their coping capabilities→ stress and depression amount Selection process: Selection of activities that are people are able to do	Related to self efficacy beliefs→ self efficacy is predictor of the behavior	Explains how self efficacy affects the human behavior in a comprehensive context. Has high reputation in wide variety of disciplines.	(Bandura, 1977a, 1997; Bandura & Adams, 1977) Also in; (Pajares, 2002)	*Attribution *Expectancy Value *Self efficacy *Social Learning

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
Social Cognitive	Behavior Behavior Change Self-efficacy	→Explains causal structure that address both development of competencies and regulation of action →Internal factors, behavioral patterns and environmental events have mutually cause people's actions. →SCT analyzes behavior in 3 dimensions: Symbolic meaning: Acquisition of knowledge, new ideas, practices Adoption determinants: Perceived self-efficacy, outcome expectancies Social networks: Structural interconnections with the social environment	Within reciprocal activity of internal factors, behavioral patterns and environment	Explains how a behavior is formulated by covering all the environmental and personal factors. Analyzes social diffusion of new styles of behavior.	(Bandura, 1989, 1997, 2001) Also in: (Pajares, 2002; "Social Cognitive Theory," 2010)	*Planned Behavior *Self-efficacy
Self Perception	Attitudes	→People are observers of their own attitudes and these attitudes are inferred from their own behaviors →Different that behavior theories, the theory predicts attitudes through self observations of behaviors →Rather than reducing the cognitive dissonance, attitude change is affected by the responsibility of positioning the person towards behaviors	Self perception process-not a cognitive dissonance	Attitudes are predicted by the behaviors Opposite of what the Cognitive Dissonance Theory claims	(Bem, 1967, 1972) Also in, (Fiske, 2004; Petty & Cacioppo, 1996)	*Cognitive dissonance *Attribution
Expectancy value models	Behaviors Values	→Theory was first explored in 1970' and then is further develeoped into different models including as Theory of Reasoned Action →Main arguement is that when there are one than one opportunuties to chose within a	Evaluation of outcome behavior and it's value	Influentials of a behavior other than values is not covered	(Fishbein & Ajzen, 2005) Also in; ("Expectancy Value Models," 2010; Palmgreen, 1984)	*Reasoned Action

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
		series of behaviors, people try to pick one that is believed to cover more success and value.				
Theory of Reasoned Action (TRA)	Behavior Behavior change Attitude	→The goal of the theory is to predict and understand the determinants of actual behavior. →Attitude toward the behavior and subjective norm are the main determinants of the behavior. →The theory evolved into Theory of Planned behavior.	Evaluations of attitudes and subjective norm	Behavior is predicted by the intentions	(Ajzen, 1991, 2005; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 2005) Also in: (Benoit & Benoit, 2008; Petty & Cacioppo, 1996)	*Planned Behavior *Expectancy Value Models
Theory of Planned Behavior (TPB)	Behavior Behavior change Motivation Attitude	→Perceived behavioral control was added to predictors of behavior in addition to attitude toward the behavior and subjective norm. →Central factor in the theory of planned behavior is the individual's intention to perform a given behavior. →Motivations of the person are also influential on the intentions to perform a behavior. →3 predictors of behavior: Attitude towards behavior is influenced by behavioral beliefs of the person Subjective norms are affected by normative beliefs Perceived behavioral control is affected by control believes	Through motivations and belief evaluations	TPB is evolved from TRA. Motivations holds important place in transformation of intentions into behavior.	(Ajzen, 1991, 2005; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 2005) Also in; (Benoit & Benoit, 2008; Petty & Cacioppo, 1996)	*Reasoned Action *Expectancy Value Models
Health belief model	Health Behaviors,	→Considering the health behaviors, there are 4 constructs that define the readiness to act:	Through evaluations of	The theory is a combination of	(Rosenstock, Strecher, & Becker,	*Social Learning

Table 24. Literature Review of Psychology Literature (Continued)

Theory/Model	Focus	Main arguments and explanations-aim	How people change	Status-Position	Reference	Related Theories
Table 24. Cont'	Behavior Change	Perceived susceptibility Perceived Severity Perceived Benefits Perceived Barriers →Evaluation the perception, people generate cues to possible behaviors (action) and these actions are determined by self-Efficacy	health risks and personal abilities	different theories Applied to understand wide variety of health behaviors	1988) Also in; ("Health Belief Model," 2010)	*Theory of Planned Behavior *Self efficacy
Transtheoretical Model *Table 24. Cont'*	Health Behaviors, Behavior Change	→Theory claims that one single theory cannot explain behavior and behavior change, therefore a wide variety of theories have been processed to create a"transtheorotical model". →Theory defines 5 stages of change: Precontemplation (not any attempt to take action) Contemplation (thinking of action) Preparation (getting readily for the action) Action (starting an action) Maintenance (keeping action) →Theory also defines "processes" thought which people change their attitudes. Some of these processes are cognitive, some are behavioral. →Process of change starts with first cognitive processes and followed by behavioral processes. →Self efficacy plays important role in changing health behaviors	Through "processes of change"	Explain grounds for monitoring health behavior change Applied to understand wide variety of health behavior, including physical activity changes	(Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992; Prochaska, Redding, & Evers, 2008; Prochaska & Velicer, 1997) Also in: (Marcus & Forsyth, 2003)	All behavior and behavior change related models

APPENDIX B:

PHYSICAL ACTIVITY STAGES OF CHANGE

Original Version

Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, or any other activity in which exertion is at least as intense as these activities.

For activity to be regular, it must add up to a total of 30 minutes or more per day and be done at least 5 days per week. For example, you could take one 30-minute walk or take three 10-miute walks for a daily total of 30 minutes. For each of the following questions, please circle Yes of No. Please be sure to read the questions carefully.

		Yes	No
1.	I am currently physically active	O	O
2.	I intend to become more physically active in the next 6 months.	O	O
3.	I currently engage in regular physical activity.	O	O
4.	I have been regularly physically active for the past 6 months.	O	O

If (question 1=0 and 2=0) then the person is at stage 1. (Precontemplation)

If (question 1=0 and 2=1) then the person is at stage 2. (Contemplation)

If (question 1=1 and 3=0) then the person is at stage 3. (Preparation)

If (question 1=1 and 3=1 and question 4=0) then the person is at stage 4. (Action)

If (question 1=1 and 3=1 and question 4=1) then the person is at stage 5. (Maintenance)

Turkish Version

Orta düzeyde fiziksel aktiviteler nefes alımında ve kalp atımında biraz artış gözlenen aktivitelerdir. Ritimli yürüyüş, dans, bahçe işleri, düşük şiddette yüzme veya arazide bisiklet sürme gibi etkinlikler orta düzeyde aktivite olarak değerlendirilir.

Aşağıdaki sorular sizin **orta düzeyde** fiziksel aktiviteye katılım durumunuzla ilgilidir.

Bu aktivitelerin **düzenli sayılabilmesi** için, haftada en az 5 gün ve en az 30 dakika olması gerekir. Örneğin, 30 dakika süreyle yürüyüş yapabilir veya 10 dakikalık 3 farklı aktivite ile 30 dakikayı doldurabilirsiniz.

Lütfen her soru için Evet veya Hayır seçeneğini işaretleyiniz.	Evet	Hayır
1. Şu anda orta düzeyde fiziksel aktiviteye katılmaktayım.	O	O
2. Gelecek 6 ayda orta düzeyde fiziksel aktiviteye katılımımı arttırmak niyetindeyim.	O	O
3. Şu anda düzenli olarak orta düzeyde fiziksel aktivite yapmaktayım.	O	O
4. Son 6 aydır düzenli olarak orta düzeyde fiziksel aktiviteye katılmaktayım.	O	O
5. Geçmişte, en az 3 aylık dönemde düzenli olarak orta düzeyde aktivitelere katılırdım.	O	O

Eğilim Öncesi (EÖ)= 1. soru=Hayır; 2. soru=Hayır

Eğilim (E)= 1. soru=Hayır; 2. soru=Evet

Hazırlık (H)= 1. soru=Hayır; 2. soru=Evet

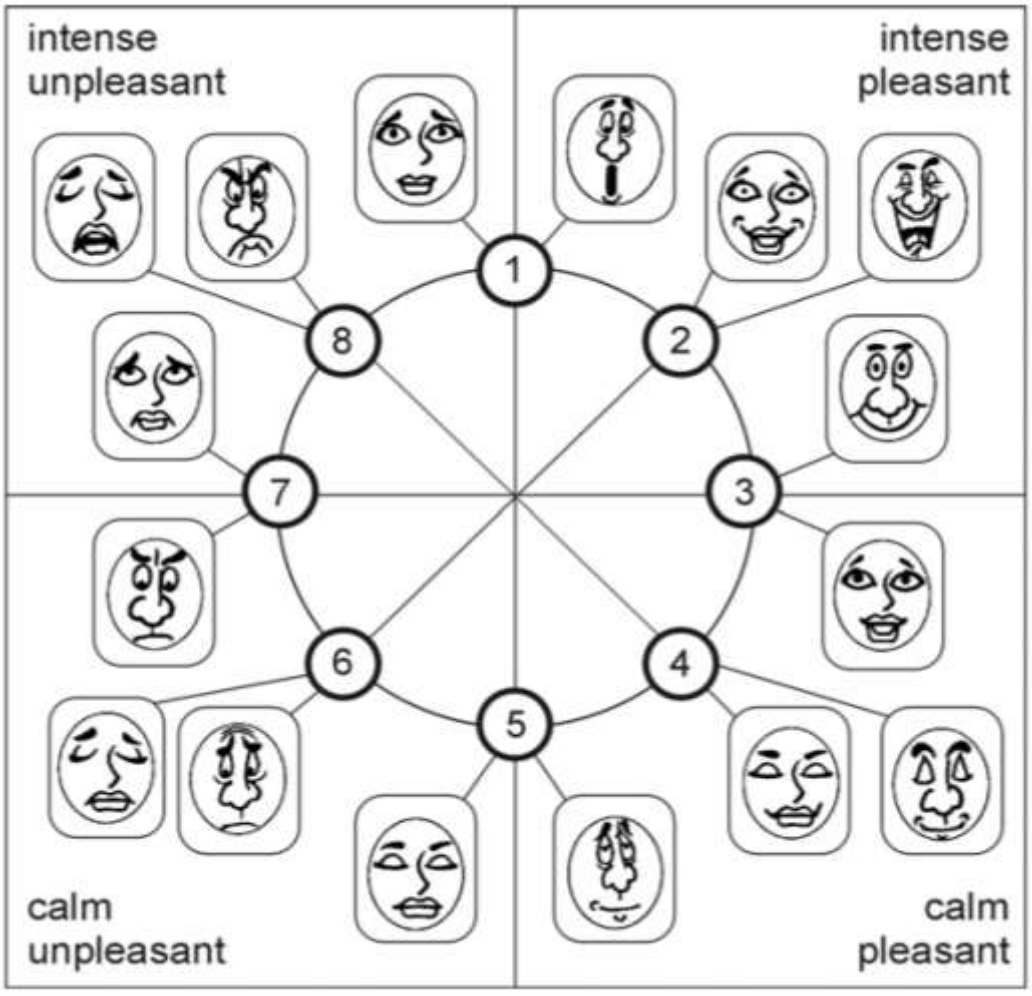
Hareket (HT)= 1. soru=Evet; 3. soru=Evet; 4. soru=Hayır

Devamlılık (D)= 1. soru=Evet; 3. soru=Evet; 4. soru=Evet

APPENDIX C:

NON-VERBAL PICTORIAL SCALE

Original Version

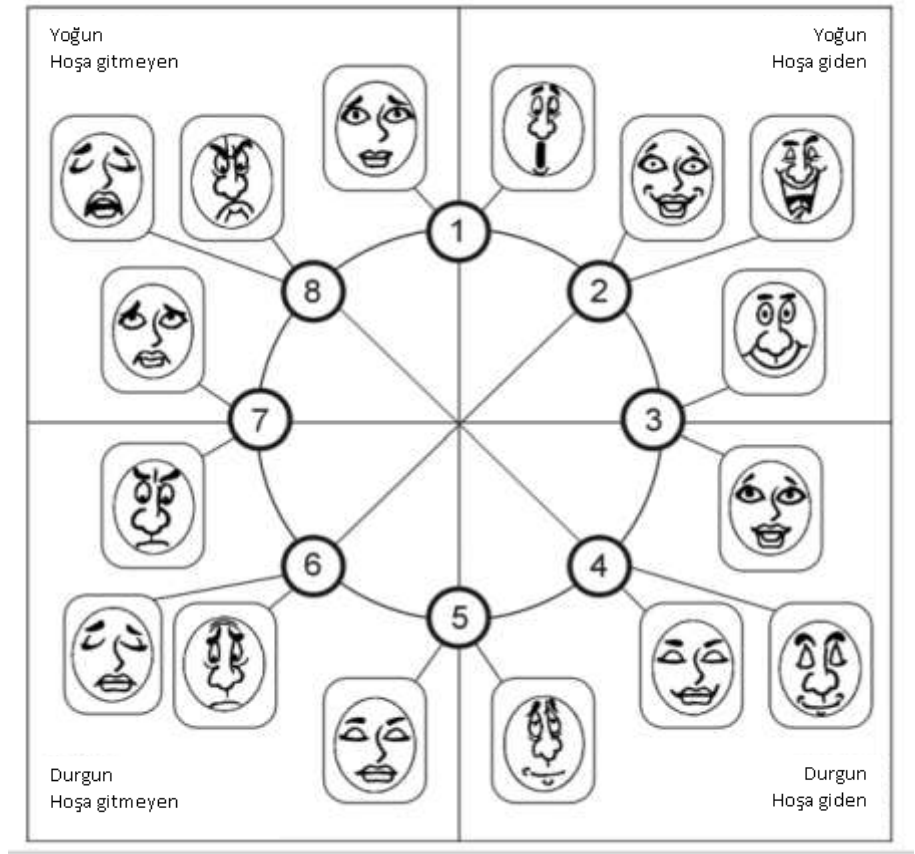


Nonverbal Pictorial Scale (Desmet et al., 2001)

Version Used in the Study-1

Ürün ile ilgili duygularınızı, lütfen aşağıda görselleştirilmiş ifadeleri daire içine alarak belirtiniz.

Belirteceğiniz duygular bir veya birden fazla olabilir



CHAPTER D:

SMART WEARABLE PRODUCT QUALITIES SCALE

English Version

Thinking about the experience that you have been with the given wearable product, please circle how **satisfied you are** about the listed qualities of the product:

Visual Qualities	Not at all			Moderate			very much
Having an aesthetic appearance	1	2	3	4	5	6	7
Having an elegant appearance	1	2	3	4	5	6	7
Having an impressive appearance	1	2	3	4	5	6	7
Having a fanciful appearance	1	2	3	4	5	6	7
Having a delicate appearance	1	2	3	4	5	6	7
Being out of ordinary design	1	2	3	4	5	6	7
Usage of appealing colors	1	2	3	4	5	6	7
Having a brand new look	1	2	3	4	5	6	7
Having a nice design	1	2	3	4	5	6	7
Having a plain design	1	2	3	4	5	6	7

Novelty	Not at all			Moderate			Very much
Presence of advanced technology	1	2	3	4	5	6	7
Usage Different/out of ordinary technology	1	2	3	4	5	6	7
Usage of cutting edge technology	1	2	3	4	5	6	7
Offering innovative features	1	2	3	4	5	6	7
Good/appropriate usage of technology	1	2	3	4	5	6	7
Offering multi-function usage	1	2	3	4	5	6	7
Offering creative features/solutions	1	2	3	4	5	6	7
Offering smart features	1	2	3	4	5	6	7
Being suitable for different applications	1	2	3	4	5	6	7

Usefulness	Not at all			Moderate			Very much
Presenting understandable interactions	1	2	3	4	5	6	7
Giving usable information	1	2	3	4	5	6	7
Being durable	1	2	3	4	5	6	7
Presence of an accessible interface	1	2	3	4	5	6	7
Presenting understandable feedbacks	1	2	3	4	5	6	7
Being harmless to body	1	2	3	4	5	6	7
Being suitable for daily usage	1	2	3	4	5	6	7
Having characteristics that provide privacy	1	2	3	4	5	6	7
Having a design that doesn't restrict freedom of movement	1	2	3	4	5	6	7
Being convenient to use while in the motion	1	2	3	4	5	6	7
Could be fixed on some part of the body	1	2	3	4	5	6	7

Wearability	Not at all			Moderate			Very much
Being suitable to be carried around in different ways while attached to the body.	1	2	3	4	5	6	7
Being non-apparent to the eye while not being used	1	2	3	4	5	6	7
Being suitable to be carried around on different parts of the body	1	2	3	4	5	6	7
Can be used as an accessory	1	2	3	4	5	6	7
Being similar to accessories such as watch, wristbands.	1	2	3	4	5	6	7
Making its presence forgettable	1	2	3	4	5	6	7
Having a flexible shape	1	2	3	4	5	6	7
Having a childish appeal	1	2	3	4	5	6	7
Having a form in harmony with the body	1	2	3	4	5	6	7
Being able to get smaller	1	2	3	4	5	6	7
Being able to interact with the human body	1	2	3	4	5	6	7
Looks like a toy	1	2	3	4	5	6	7
Being able to operate while attached to human body	1	2	3	4	5	6	7

Interactivity	Not at all			Moderate			Very much
Presence of buttons that are suitable for use	1	2	3	4	5	6	7
Presence of screens that are suitable for use	1	2	3	4	5	6	7
Offering multimedia features	1	2	3	4	5	6	7
Visibility of buttons while being used	1	2	3	4	5	6	7
Having reminding features	1	2	3	4	5	6	7
Being suitable to be carried around in a pocket	1	2	3	4	5	6	7
Having a touch-operated interaction	1	2	3	4	5	6	7
Usage of the accustomed technology	1	2	3	4	5	6	7

Ease of Use	Not at all			Moderate			Very much
Having an appropriate size for usage	1	2	3	4	5	6	7
Being convenient to use - ease of use	1	2	3	4	5	6	7
Being easy to hold	1	2	3	4	5	6	7
Being practical	1	2	3	4	5	6	7
Offering freedom of movement	1	2	3	4	5	6	7
Easy to be carried around –ease of carrying	1	2	3	4	5	6	7
Having an ergonomic design	1	2	3	4	5	6	7
Having a manageable weight	1	2	3	4	5	6	7
Offering defined usages	1	2	3	4	5	6	7

Product Expression (Pragmatic)	Not at all			Moderate			Very much
Being suitable for the age	1	2	3	4	5	6	7
Being suitable for any gender (male, female)	1	2	3	4	5	6	7
Having serious, businesslike look	1	2	3	4	5	6	7
Having technological appearance	1	2	3	4	5	6	7
Having electronic appearance	1	2	3	4	5	6	7
Having modern appearance	1	2	3	4	5	6	7
Usage of the appropriate color for the technology	1	2	3	4	5	6	7
Having the quality appearance	1	2	3	4	5	6	7
Usage of technological colors (metallic/grey/black, etc)	1	2	3	4	5	6	7
Having jewelry like appearance (expensive stones/fancy etc)	1	2	3	4	5	6	7
Suitable for personal taste	1	2	3	4	5	6	7
Having an accustomed look	1	2	3	4	5	6	7

Original Version

GİYİLEBİLİR AKILLI-TEKNOLOJİK ÜRÜN ÖZELLİKLERİ ANKETİ

Bu anket kullanmakta olduğunuz/kullanmış olduğunuz teknolojik ürünün özelliklerini değerlendirmenize yöneliktir. **Kişisel bilgileriniz ve ankete vereceğiniz cevaplar gizli tutulacak, ilgili doktor ve danışman dışındaki üçüncü şahıslarla paylaşılmayacaktır**.

Bu bölümde, kullanmış olduğunuz giyilebilir ürünü düşünerek, aşağıdaki **ürün özelliklerinin sizin için, (A)ne kadar önemli olduğunu** ve kullandığınız üründen **(B)ne kadar memnun kaldığınızı** belirtiniz.
Yaşınız:

Cinsiyetiniz: K E

Ürünün Görsel Özellikleri	Hiç			Orta			Çok
Estetik görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Şık görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Etkileyici görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Gösterişli görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Narin görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Farklı / değişik tasarımının olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Çekici renk (parlak/canlı vb.) kullanımı ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünü Taşıdığı Anlamlar	Hiç			Orta			Çok
Kullanan yaşa uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kullanan cinsiyete (erkeksi, kadınsı vb) uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Ciddi görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Teknolojik görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Pahalı görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünü Taşıdığı Anlamlar	Hiç			Orta			Çok
Elektronik görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Modern görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Teknolojiye uygun renk kullanılması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kaliteli görünmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Sunduğu Yenilikler	Hiç			Orta			Çok
İleri teknoloji sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Farklı/değişik teknolojilerin kullanılması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Yeni/son teknoloji kullanılması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Yenilikçi özellikler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Teknolojinin iyi uygulanmış olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Çok fonksiyonlu kullanım sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Yaratıcı özellikler/çözümler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Akıllı özellikler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
İnsan vucuduyla iletişim kurması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Kullanımının Kolaylığı	Hiç			Orta			Çok
Rahat kullanılabilmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Elde tutmasının kolay olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Pratik kullanımının olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Özgür hareket olanağı sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Taşımasının kolay olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Ergonomik olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Ağırlığının kullanıma uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Ürünün Vücutla Kurduğu İlişki	Hiç			Orta			Çok
Vücutta farklı şekillerde taşımaya uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kullanılmadığında gözden yok olabilmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Vücutta farklı yerlerde taşımaya uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Aksesuara (saat, bileklik vb) benzer olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Varlığını unutturabilmesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Şeklinin esnek olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Aksesuar olabilme özelliğinin olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Şeklinin insan vücuduyla uyumlu olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Vücut üzerindeyken çalışabilir olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Kullanışlılığı	Hiç			Orta			Çok
Anlaşılabilir etkileşimler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kullanılabilir bilgiler vermesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Uzun süre kullanılabilir olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Küçülebilir olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Erişilebilir ara yüzünün bulunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Anlaşılabilir geribildirimler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Kullanışlılığı	Hiç			Orta			Çok
Vücuda zarar vermemesi ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Günlük kullanıma uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Gizlilik/mahremiyet sağlayan özellikleri olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Hareket özgürlüğünü kısıtlamayan tasarımı olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Hareket halinde iken kullanıma uygun olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Etkileşim Özellikleri	Hiç			Orta			Çok
Kullanıma uygun tuşların varlığı ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kullanıma uygun ekranların varlığı ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Multimedya özellikler sunması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Kullanım sırasında tuşların görünebilir olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Varlığını hatırlatıcı özelliğinin olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Dokunmatik etkileşimi olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Eğlenceli etkileşiminin olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
İyi tasarımının olması ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7
Boyutların kullanıma uygunluğu ne kadar önemli?	1	2	3	4	5	6	7
Bu özellik açısından üründen ne kadar memnunsunuz?	1	2	3	4	5	6	7

Ürünün Yarattığı Motivasyon	Evet	Hayır
Bu ürün beni fiziksel aktivite yapma konusunda motive etti.		
Ürünü daha uzun süre kullanmaya devam etmek isterim.		

APPENDIX E:

PRODUCTS AND SYSTEM SCREENED BEFORE SELECTION

Table 25. Product Reviewed

Product type	*Commercial Product Examples*	*Product Images*	*Brief Explanation*
Wearable / mobile product *(device, application, website)*	Body Media		✓ Bluetooth enabled mobile application ✓ Measures calories, steps, sleep quality (in most accurate way) ✓ New armband is slimmer ! Expensive ($249) ! Needs website subscription ($12) ! Not resistant to water ! User has to use website/application to see the graphs ! Has to be carried on arm
	New Body Media Arm Band		✓ Smaller in size ! Expensive ($179) ! Is not bluetooth enabled
	Nike Fuel Band		✓ Wristband like ✓ $149 ✓ Invisible interms of being like a watch Not resistant to water
	BodyBug		✓ Similar to BodyMedia

Table 25. Product Reviewed (Continued)

Product type	*Commercial Product Examples*	*Product Images*	*Brief Explanation*
	Basis-Heart Rate Monitor for Health and Fitness		✓ Looks simple ✓ 3D accelometer ✓ "Track the intensity of your workout through sweat levels, from warm-up to recovery. See how each activity in your life is impacting your health and fitness, from taking the stairs at work to running a marathon." ✓ "Track your body heat levels for an accurate measure of the calories you burn on your morning run, or even at work. See when your calorie burn rate is at the most intense and learn the best time to add a workout to your week." ! Is not on market yet- seems to be conceptual
	Fit Bit	 	✓ Small relative to BM ✓ Can be carried anywhere on clothes ✓ Can be clipped to the clothes ✓ Major information can be seen on the small screen of device ✓ Web site/IPhone application- free ✓ Pedometer like ✓ Seems to measure sleep quality ✓ The web interface is clear ! Can be lost (as its small) ! Can be forgotten to carry Not resistant to water User has to define the hours of sleep- device cannot catch the sleep if the user does not define it (own experience)
	Live Up		✓ $99 ✓ Band and app works together-no website subscription is required ✓ Device is sweat proof and water resistent ✓ Measures sleep quality

Table 25. Product Reviewed (Continued)

Product type	*Commercial Product Examples*	*Product Images*	*Brief Explanation*
		 	
	Phillips Direct Life		$149 ✓ No web site registration fee ✓ Small enough to be carried ✓ Can be carried anywhere on clothes ✓ Level of activity can be seen on the device Computer connection is required to see the data
	Motorola Active		✓ Watch-tracker ✓ No website-app Expensive
	Timex Health Tracker		Automatically records distance, steps and calories burned all day Diet diary will keep track of units or calories consumed daily Daily activity tracker with 7-days memory to review progress Customizable goals chime in halfway and at completion of goal Workout mode will display elapsed time, distance and exercise pace intensity in real time (slow/mod/fast) One-time easy setup with personal setting for accuracy
	NewYu		✓ Free online dashboard ! Does not have widespread use

Table 25. Product Reviewed (Continued)

Product type	*Commercial Product Examples*	*Product Images*	*Brief Explanation*
			 
	Scoche My Trax		Used only when doing sportive activity Has an app
	MyTrak	 	$99 "turning inactive and marginally active employees into active, healthy members of your company ensuring employees achieve a normal Body Mass Index (BMI) through weight loss programs keeping employees engaged and motivated to succeed through social networking, education and supportive coaching improving the overall well-being of your employees through stress-reduction programs and life coaching"
	Reebok Pedometers & Watch		Pedometer only 

Table 25. Product Reviewed (Continued)

Product type	*Commercial Product Examples*	*Product Images*	*Brief Explanation*
			
	Omron Pedometer		Uses advanced 3D Smart Sensor
Only Mobile phone applications (application)	iSmooth Run		Uses GPS to understand user activity GPS, Accelerometer based and Footpod if it is connected. Automatic switching of modes between GPS and Accelerometers based on GPS signal quality.
	Pedometer		Similar to any other step counters Interface is not that good!
	Calorie Counter Pro		User can log the food by scanning the barcode of the foods Similar to any other step counters

Table 25. Product Reviewed (Continued)

Product type	***Commercial Product Examples***	***Product Images***	***Brief Explanation***
Websites + *(applications are also available)*	All in Pedometer		Bad interface! Only tracks steps in a set time 
	Dailyburn		The system is one of the well developed one
	Run Keeper	 	The system is one of the well developed one Works with fitbit if desired User has to log each and every activity Some workouts can be seen on the page
	FitBit		Website can be used without the product, it would be good to compare the users through this
Others	*Withings + Body Scale*		Has an IPhone Application- and it enables to measure the weight everywhere It's not an activity monitoring device

Table 25. Product Reviewed (Continued)

Product type	***Commercial Product Examples***	***Product Images***	***Brief Explanation***
	NikePlus + SportsBand		✔ Records the data, ✔ User can see the progress on the small screen Works only with Nike+ shoes

APPENDIX F:

RECRUITMENT TEXT OF STUDY2

WE WOULD LIKE TO HEAR YOUR EXPERIENCE!

We are a group of researchers at Carnegie Mellon who want to help people **try out products to increase their physical activity.** We are looking for adults between the ages of 20 and 65 to help us **test a websites and applications for monitoring physical activity** and letting us know about your experience.

If you are over 20 and interested in participating, please email **armagank@andrew.cmu.edu** with comments or questions. You will be compensated **$25 for the initial interview, and $50 for five weeks of participation** in the study.

If you think that you can be one of our subjects, please join us!

Assoc. Prof. Jodi Forlizzi
Researcher Armagan Karahanoglu
Prof. Dan Siewierok

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APPENDIX G:

QUESTIONS FOR STUDY 2

QUESTIONS FOR STUDY 2- STAGE1
Invite to respondent:
[If participant agrees, go to next page and ask specific questions.]
Specific questions
Thank you for agreeing to participate! In order to prepare for our visit, we'd like you to answer a few questions.

RESIDENT SCREENER

Contact Info

Name:
Address:
City, State, Zip:
Home phone:
Cell phone:
Email:

1. Who do **you live with**?
( ) None ( ) Spouse ( ) Partner ( ) Children ( ) Other…….

2. What is **your birth year**?
……..……

3. **Gender**: □ Female □ Male
4. Your **highest level of academic achievement**:
□High School □Bachelor's Degree □Master's Degree □Doctorate Degree (Ph.D.)
□Other (Please specify):
……

5. How much of **your time do you spend at home** / work?
……..……

6. Are there any technological devices or products that you **carry every day**? *What are these?*
……..……

7. What **type of phone is yours**? (Android or Iphone?)
……..……..

8. How many hours of your day do you **spend on the internet** in general?
……...……

9. Do you have any **holiday plans** in next 5-weeks' time?

10. Are you willing to use any of these products?
( ) A wearable physical activity tracking tool that will be worn on the arm at least 23 hours of a day, a mobile application (IPhone/Android) and website of the product
( ) A pedometer-like product and the mobile application (IPhone/Android) of the product
( ) A website only to log daily physical activities and mobile application of the website

Stages of Change

Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, or any other activity in which exertion is at least as intense as these activities. So;

		Yes	No
1.	Are you currently physically active?	O	O
2.	Do you intend to become more physically active in the next 6 months?	O	O

For activity to be regular, it must add up to a total of 30 minutes or more per day and be done at least 5 days per week. For example, you could take one 30-minute walk or take three 10-minute walks for a daily total of 30 minutes.

		Yes	No
3.	Do you currently engage in regular physical activity?	O	O
4.	Have you been regularly physically active for the past 6 months?	O	O

If question 1 = 0 and question 2 = 0, then you are at stage 1 (Pre-contemplation)
If question 1 = 0 and question 2 = 1, then you are at stage 2 (Contemplation)
If question 1 = 1 and question 3 = 0, then you are at stage 3 (Preparation)
If question 1 = 1, question 3 = 1, and question 4 = 0, then you are at stage 4 (Decision/action)

Thanks again for answering these questions.

QUESTIONS FOR STUDY 2- STAGE2

Get to Know Questions

- Were you born in Pittsburgh? If not, how long have you lived here? Where did you live before this?
- What is your **current occupation**? What is your **primary functional work area**? What do you think **your occupation will be** in five years? What are your **goals for this year**?

- How many hours do **you spend at work**/school? So, this affects your sleeping hours. At what time do you **generally get up and go to bed** in weekdays?
- How your **sleeping hours change at the weekends**?
- How long have you **lived in this house**? Can you show the house? **[Can we take a few pictures?]** How long do you think **you will continue living here**?

- Do you own **a car**? If so, where do you typically drive during the week? Do you walk or take public transportation regularly? If so, where?

- For an ordinary week day, what type of **activities** do you do from the **beginning of the day till the end of the day**?

- What about your physical activity? Do you do regular **physical activity**? **How many** times a week? **How do you schedule your time**?
- What **type of physical activity** do you do generally? Take walks or do something specifically?
- Did you have **any injuries** that affected your physical activity habits?

- What about your **eating habits**? Do you **pay attention to your diet**? Do you think that you eat properly? Do you have a balanced diet that **you follow every day**? Describe what you **eat on a typical day, from beginning to end**?

Thank you for these answers.

QUESTIONS FOR STUDY 2- STAGE3

I want to make sure that everything is ok with the FitBit /Body Media.
I have a couple of questions.

- Are you able to log on the system? Do you have any problems with that?
- And the system usage? Is everything going ok?
- Anything that you would like to ask?
- Are you carrying the product? Do you have any problems with that?
- Are you happy with the product and the system?

Apart from these, if you have any questions, you can call me anytime or send an email.

Thanks.

QUESTIONS FOR STUDY 2- STAGE4

We are interested in your feedback about your experience with the product today!

Part 1 (Page2)

Please tell us **about your experience** with the product/system from the beginning of the day until now:

I *(decided to) check(ed) the data/look at the data* with the product *(when/after/before doing)*……

I interacted with the product after I *(did) (explain what you were doing)*.....……

Explain your experience in detail-how did you find it?

.....

.....

What did you do after interacting?) .....

Tell us more about what was engaging for you during your experience(s)?

……..

Part2 (Page2)

We would like to understand when you interacted with the product today. Please define the day time you have interacted with the product and define the level of engagement.

Please define the day time you have interacted with the product						
	In the Morning	Lunch Time	In the Afternoon	In the evening	At night	After midnight
I had no interaction	○	○	○	○	○	○
1-3 Times	○	○	○	○	○	○
4-6 Times	○	○	○	○	○	○
7-9 Times	○	○	○	○	○	○
More than 10	○	○	○	○	○	○
Please scale how engaging was your experience						
Extremely engaging	○	○	○	○	○	○
Very engaging	○	○	○	○	○	○
Moderately engaging	○	○	○	○	○	○
Slightly engaging	○	○	○	○	○	○
Not engaging at all	○	○	○	○	○	○

Please rate today' experience in terms of these:

	1	***2***	***3***	***4***	***5***	***6***	***7***	
Functions poorly	○	○	○	○	○	○	○	Functions well
Does not make me feel good	○	○	○	○	○	○	○	Makes me feel good
Affects my social life negatively	○	○	○	○	○	○	○	Affects my social life positively
Is not aesthetically pleasing	○	○	○	○	○	○	○	Is aesthetically pleasing
Communicates with me poorly	○	○	○	○	○	○	○	Communicates with me well
Does not motivate me	○	○	○	○	○	○	○	Motivates me positively
Does not keep me curious	○	○	○	○	○	○	○	Keeps me curious about the data
Is poor in terms of interaction	○	○	○	○	○	○	○	Is rich in terms of interaction

QUESTIONS FOR STUDY 2- STAGE5 (QUESTIONS ASKED TO BM09)

How are you today? I would like to thank you once more for your feedback about your experience in using the product. We have your daily experience ratings and our interview will be a wrap-up and summary of your 5-weeks' experience.

Before we start the interview, I need you to fill out these questionnaires. First is physical activity questionnaire. And the second is a general experience questionnaire. (Give the form)

Interview Questions

Ask for examples of physical activity changes – positive and negative examples

Now that you have used the product for 5 weeks, can we talk about your physical activity behaviors?
At the beginning of the research, you had a goal.
Could you state once more, what was your aim to use this product-to lose weight or to get active?
Did you achieve this goal? How did the device help or hinder this goal?
Was it different in week 1 vs. Week 5? How?

Do you think that the product helped you to change your activity habits?
No: Why do you think so?
Yes: How did your habits change? Why do you think so?

Going forward, **would you continue to use the product**? Why or why not?
Do you think you will **maintain the changes they instilled in your behavior**? Why or why not?

Can you talk about its **functions**? What do you think about its functions?
What affected this?

Did you also try using the app? For what purposes did you use it?
Could you suggest anything to change so that it will have better functions?
Do you have any suggestions for the application // and for the website?

For the question of **makes me feel good**, I can see that you gave X.
What affected this?
What do you think about it?

Could you suggest anything to change so that if will make you feel good?
Do you have any suggestions for the application // and for the website?

What about **your social experience? Can you give examples of social product use?**
For instance, what do you think about sharing your data with others, reporting your activity to others, sharing information about the product or any aspect of it?

Could you explain the times you told about the device to some of the students? What happened?
Could you also explain why you forgot to wear the device last week?

I can see that, for the question of "**affects my social life positively**" you gave (X)
Considering these, do you like social aspects of this product?
Could you suggest anything to change?

And for the **aesthetical appeal**, did you like the product' aesthetics?
What affected this? Could you talk about it?

What about the appearance of the website?
And the app?

Do you have suggestions for the aesthetics of the product?
What would you suggest for the aesthetics of the website?

What do you think about the **communication** of the product? What do you like about it?
And now you again gave (X)
What affected this?

What do you think about communication with the product? /With the web site/ with the app?

Could you suggest anything to change?
Any suggestions for the application?
And for the website?

What about **the way product motivates you? Could you talk about it? Did it motive you?**
Your ratings do not change through the end of 4 weeks.
What affected this?
Could you talk about it?

Could you suggest anything to change to motivate you?

For the question of**; keeps me curious about the data, c**ould you explain when specifically you feel curious about what you do?
Which data would make you curious and check what you do?
You reported that it makes you think about the data and plan your day accordingly. How did it affect you?

Were you compelled to look at the data?
How frequently?
What would prompt you to look at the data more frequently?
Could you make any suggestions to change?

For the last question of the questionnaire, your scores about "**rich in terms of interaction"**, you gave very low scores. Can you talk about it?
What do you think about the interaction?

What were your expectations?
How do you think the system should be changed to offer better interaction with the product?

And I can see that when you come to the end of this 5-weeks' usage, what do you think is **engaging** for you? What do you expect in terms of engaging experience?

What do you think the most engaging part of your experience? And least engaging?
Why do you think so?
For better engaging experiences, what do you thing the system should offer?

And lastly, think that we will design new products and systems that will try to motivate people to **exercise regularly for the future**, and we **want to design for engaging experiences**, what do you offer?

What could these products do?

How smart do you think the future products/systems should be?
What would be **your expectations** for the future products?

Our study ends here. Thank you so much for your participation.

[Last payment $50]

Stages of Change

Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, or any other activity in which exertion is at least as intense as these activities. So;

	Yes	No
1. Are you currently physically active?	O	O
2. Do you intend to become more physically active in the next 6 months?	O	O

For activity to be regular, it must add up to a total of 30 minutes or more per day and be done at least 5 days per week. For example, you could take one 30-minute walk or take three 10-minute walks for a daily total of 30 minutes.

	Yes	No
3. Do you currently engage in regular physical activity?	O	O
4. Have you been regularly physically active for the past 6 months?	O	O

If question 1 = 0 and question 2 = 0, then you are at stage 1 (Pre-contemplation)
If question 1 = 0 and question 2 = 1, then you are at stage 2 (Contemplation)
If question 1 = 1 and question 3 = 0, then you are at stage 3 (Preparation)
If question 1 = 1, question 3 = 1, and question 4 = 0, then you are at stage 4 (Decision/action)

Thanks again for answering these questions.

Your Overall Experience

Please rate your overall experience with the product/system of 5-week'usage.

	1	***2***	***3***	***4***	***5***	***6***	***7***	
Functions poorly	O	O	O	O	O	O	O	Functions well
Does not make me feel good	O	O	O	O	O	O	O	Makes me feel good
Affects my social life negatively	O	O	O	O	O	O	O	Affects my social life positively
Is not aesthetically pleasing	O	O	O	O	O	O	O	Is aesthetically pleasing
Communicates with me poorly	O	O	O	O	O	O	O	Communicates with me well
Does not motivate me	O	O	O	O	O	O	O	Motivates me positively
Does not keep me curious	O	O	O	O	O	O	O	Keeps me curious about the data
Is poor in terms of interaction	O	O	O	O	O	O	O	Is rich in terms of interaction

CHAPTER H:

DATA ANALYSIS DETAILS OF STUDY1

This appendix includes data analysis details of the first study.

Table 26. Data Analysis Details of Study1

System Quality (SQ)	***Usage of Code***	***%***	***Related System Characteristics (Number of comments)***	***Strongly Related SQ***	***Example User Comments***
Usefulness	Offering usable and useful functions	18.36	Usage Being multifunctional [55] Being able to forget its presence [55] Having good functions [35] Being flexible [18] Interaction Having good interaction quality [81] Having good data quality [70] Visual Having appropriate size [57] Having technological elements [21] Body Relation Being suitable for movements [17] Being suitable for versatile usage [16]	Interactivity Pleasing Aesthetics Wearability	"I think it should give me personal suggestions after analyzing what I do and eat for like 10 days. Now, it is not doing this, it is just measuring." (User18)
Interactivity	Making the interaction possible and easy to understand	13.37	Interaction Having good interaction quality [356] Having good data quality [32]	Ease of use Usefulness	"Because someone asked me, about it like "Is it going to show my data immediately when I put that thing on my arm?" So, for some people and me, instant data is very important" (User 06)
Wearability	Being convenient for mobility and being invisible to others while carrying	11.44	On Body Relation Being suitable for versatile carrying [112] Being compatible with the body [83] Usage Having good functions [70] Being able to forget its presence [45] Being easy to use [24] Suitable for use during sleep [15] Visual	Pleasing Aesthetics Usefulness Ease of use Social Interaction	"In relation to what I wear, I would like it to have the flexibility to be worn on different parts of me.." "I don't want it to be visible, so it should be carried on different parts of me." (User17)

Table 26. Data Analysis Details of Study1 (Continued)

System Quality (SQ)	***Usage of Code***	***%***	***Related System Characteristics (Number of comments)***	***Strongly Related SQ***	***Example User Comments***
			Having appropriate size [16]		
Pleasing aesthetics	Having appealing visual characteristics	11.20	Visual Being suitable for personal taste [115] Having appropriate size [99] Having good design quality [43] Being eye-catcher [39] Being like an accessory [31]	Social Interaction Wearability Expressiveness	"(…) But unfortunately, the dimensions of the device are seriously recognizable. I wish it would not be that noticeable.. It could even be built on me, but it is seriously noticeable. Because people asked me at all times." (U06)
Social interaction	Having qualities that go with their perceived social norms and social aspects of using the product	9.44	Visual Being eye-catcher [145] Being invisible to others [45] Being like an accessory [38]	Pleasing aesthetics Wearability Expressiveness	"(…) because, people asked me, all the time, whether I was wearing a blood pressure measuring device. Everyone's eyes go directly to this questioning whether I have a problem. It certainly is not recognized as something different." (User12)
Ease of use	Having qualities that are easy and comfortable to use	7.54	Usage Being practical to use [62] Body Relation Being compatible with the body [42] Being suitable for movements [28] Being suitable for versatile carrying [21] Visual Having appropriate size [35] Interaction Having good interaction quality [20]	Wearability Interactivity Smartness	"For instance, this strap.. is not easy to use as I expected; shape of my biceps change with my arm movements, but shape of the strap doesn't. So it becomes tight, and then there becomes a mark on my arm (..) So I think, the strap should not make me struggle with it, it should be easy for me to forget about it." (User08)
Expressiveness	Having characteristics that express personality, taste, social status, current state and	7.25	Visual Having medical device-like product language [39] Having good design quality [28] Having expensive appearance [28]	Pleasing aesthetics Social Interaction Wearability	"Because it looks like a medical product, actually it is like a medical product. I think, it was aimed to be designed like a consumer product, but now it is a medical device, like a device that your doctor advises you to use. I

Table 26. Data Analysis Details of Study1 (Continued)

System Quality (SQ)	*Usage of Code*	*%*	*Related System Characteristics (Number of comments)*	*Strongly Related SQ*	*Example User Comments*
	lifestyle of people		Having technological appearance [18] Having good material quality [18] Being appropriate to users' gender [17] Being appropriate to users' age [17] Having serious appearance [17]		actually don't care, but there may be people who feel uncomfortable with it."(User04)
Novelty	Offering novel and technological characteristics	6.43	Visual Having technological elements [51] Having good data quality [23] Having technological appearance [18] Interaction Having good interaction quality [35] Having good data quality [24]	Pleasing aesthetics Expressiveness	"There is nothing complicated or complex in this system. This thing (device) measures only certain things, and once you sync the device, on your computer, you see what it collects. It is your job to sync it. I do not really think that it is a super technological product. That's why, offering new things to the user and making those things in a practical way will be my preference." (User03)
Motivative	Having characteristics that people believe to have motivated them	4.89	Interaction Having good data quality [66] Having good interaction quality [48] Usage Being able to forget its presence [16]	Interactivity	"I think, they can make the system more enjoyable by designing more creative things. Now it only makes calculations, sets up data, but it doesn't analyze that data." (User04)
Smartness	Having indications of intelligence and act in response to collected data and user needs	4.17	Interaction Having good measurement quality [51] Having good data quality [51] Having good interaction quality [49] Visual Having technological elements [16]	Interactivity Pleasing aesthetics Motivative	"I wish it could show my heart rate, or it could sense other things when I sleep, then I'd really be more pleased with it. For instance it might give information about my breathing quality of my sleeping times." (User17)
Emotional	Offering positive	3.20	Interaction	Interactivity	"It would be fun, if it made me feel that it is

Table 26 . Data Analysis Details of Study1 (Continued)

System Quality (SQ)	***Usage of Code***	***%***	***Related System Characteristics (Number of comments)***	***Strongly Related SQ***	***Example User Comments***
experience	emotional experiences while using the product/system		Having engaging interactions [30] Having good integration quality [18]	Motivative	there. Also on online system, I'd prefer it reprehend me like "hey you! You haven't taken enough steps today, why did you do that, what is the reason for that?" Now, it is not doing this." (User16)
Comprehensibility	Having understandable product language and system language which makes the usage learnable and understandable	2.71	Interaction Having good interaction quality [77] Being able to be used in native language [17]	Interactivity Usefulness Motivative	"I think this system should be used by people who know English very well, or the system should be translated into Turkish so that I can understand better. I could only be able to make implications by using some of the words, still I couldn't understand all data, (User12)

APPENDIX I:

RESULTS OF SMART WEARABLE PRODUCT QUALITIES SCALE

Table 27. Product Related Results of Smart Wearable Product Qualities Scale

		IMPORTANCE		***SATISFACTION***	
		M	SD	M	SD
US	Being harmless to body	7.00	0.00	6.05	1.23
EA	Having a manageable weight	6.95	0.22	6.20	0.89
WE	Having a form in harmony with the body	6.90	0.31	4.50	1.99
US	Having a design that doesn't restrict freedom of movement	6.90	0.31	5.65	1.50
EA	Easy to be carried around –ease of carrying	6.90	0.31	6.15	1.09
EA	Having ergonomic design	6.90	0.45	5.60	1.47
US	Being suitable for daily usage	6.85	0.37	5.55	1.70
EA	Offering freedom of movement	6.85	0.37	5.60	1.47
WE	Being able to operate while attached to human body	6.80	0.70	6.25	1.65
US	Being convenient to use while in the motion	6.80	0.52	6.05	1.23
EA	Having an appropriate size for usage	6.70	0.57	4.65	1.81
US	Being durable	6.65	0.67	5.30	1.92
IN	Having good design	6.55	1.36	4.40	1.85
WE	Being suitable to be carried around on different parts of the body	6.25	1.29	2.75	1.94
PE	Having the quality appearance	6.15	1.18	5.45	1.15
WE	Being suitable to be carried around in different ways while attached to the body	6.00	1.26	2.95	1.96
WE	Being able to interact with the human body	5.95	1.85	4.85	2.18
WE	Being similar to accessories such as watch wristbands	5.95	1.39	3.15	1.93
WE	Having a flexible shape	5.95	1.47	3.90	2.25
AP	Having an aesthetic appearance	5.90	1.29	4.40	1.57
WE	Making its presence forgettable	5.80	2.04	4.70	1.59
US	Being able to get smaller	5.80	1.67	3.45	2.21
PE	Having modern appearance	5.60	1.50	5.20	1.58
AP	Having an elegant appearance	5.30	1.81	4.60	1.88
PE	Being suitable for the age	5.25	2.27	5.25	1.92
PE	Having technological appearance	5.20	2.07	4.85	1.69
AP	Being out of ordinary design	5.15	1.60	4.45	1.67
WE	Can be used as an accessory	5.00	2.10	3.35	1.81
AP	Having a delicate appearance	4.65	2.41	4.35	1.93
WE	Being non apparent to the eye while not being used	4.60	2.26	4.65	1.84
IN	Presence of buttons that are suitable for use	4.55	2.31	4.55	1.96
PE	Being suitable for any gender (male. female)	4.40	2.26	5.15	2.01
PE	Usage of the appropriate color for the technology	4.30	2.49	5.25	1.48
PE	Having serious business like look	4.20	2.09	5.15	1.35
IN	Visibility of buttons while being used	3.90	2.31	4.53	1.95
PE	Having electronic appearance	3.75	2.31	4.95	1.43
EA	Being easy to hold	3.65	2.62	5.95	1.15
AP	Usage of appealing colors	3.45	2.09	4.60	1.67
AP	Having an impressive appearance	3.35	2.21	4.45	1.67
AP	Having a fanciful appearance	3.10	2.07	4.40	1.79
PE	Having expensive appearance	2.35	1.57	4.30	1.56

Table 28.System Related Results of Smart Wearable Product Qualities Scale

		IMPORTANCE		***SATISFACTION***	
		M	SD	M	SD
US	Giving usable information	6.95	0.22	5.50	1.47
US	Presenting understandable interactions	6.90	0.31	5.40	1.64
US	Presenting understandable feedbacks	6.90	0.31	5.45	1.61
US	Having characteristics that provide privacy	5.35	1.73	5.00	1.65
EA	Being convenient to use - ease of use	6.90	0.31	5.20	1.47
EA	Being practical	6.90	0.31	6.00	1.26
US	Presence of an accessible interface	6.70	0.80	5.00	2.13
NO	Good/appropriate usage of technology	6.65	0.49	5.70	1.53
NO	Offering smart features	6.65	0.49	5.25	1.94
NO	Presence of advanced technology	6.40	1.14	5.50	1.54
NO	Usage Different/out of ordinary technology	6.25	1.29	5.10	1.83
NO	Offering innovative features	6.25	1.12	5.20	1.70
NO	Usage of cutting edge technology	5.90	1.65	5.40	1.57
NO	Offering creative features/solutions	5.90	1.55	4.65	1.84
NO	Offering multi-function usage	5.85	1.63	4.50	1.73
IN	Presence of screens that are suitable for use	5.00	2.15	2.75	1.80
IN	Offering multimedia features	4.85	2.08	4.35	2.30
IN	Having fun interactions	4.80	2.24	3.75	2.34
IN	Having a touch-operated interaction	4.10	2.25	3.65	2.11
IN	Having reminding features	3.95	2.52	4.40	1.85

Table 29.Means values of system Qualities

	IMPORTANCE	***SATISFACTION***
Usefulness	6.62	5.31
Ease of Use	6.44	5.81
Novelty	6.23	5.16
Wearability	5.92	4.11
Interactivity	4.93	4.11
Product Expression	4.58	5.06
Aesthetically Pleasing	4.41	4.46

APPENDIX J:

DATA ANALYSIS DETAILS OF STUDY2

This appendix includes data analysis details of the second study.

Table 30. Product Centered Factors (Continued)

System Quality (SQ)	Usage of Code	%	Related System Characteristics (Number of comments)	Strongly Related SQ	Example User Comments
Meaningful data / interactions	Having satisfactory way of accessing/ interpreting data	14.15	Interaction Learning calorie intake data [80] Learning about self-all data [50] Learning activity data [23] Learning sleep data [46] Giving suggestions [42] Learning calories burned [16] Learning number of steps [30] Learning elevations [21] Learning calorie balance [20] Usage Usage of online system [77] Usage of application only [60] Usage of device itself [59] Usage of whole system [49] Using online graphs [27]	• Usefulness • Ease of interaction • Smartness • Accuracy • Creating awareness	"It helped at least to a point because it gave me the goals that I need to indicate for the day. It helped me keep track how many calories I was actually burning versus how many I was consuming. So it did help me to monitor that." (BM06) "It gives me steps distance. I don't know what active score. That means nothing to me. So if I could take that off and instead put stairs climbed, then I would do that."(FB03)
Usefulness	Being usable. satisfies user's expectations	13.88	Interaction Learning about self-all data [76] Learning activity data [71] Learning calorie intake data [51] Learning calories burned [30] Learning number of steps [25] Usage Usage of device itself [291] Usage of application only [74] Usage of whole system [71] Usage of online system [70] Comparison with other system	• Meaningful data • Smartness • Creating awareness	"I like it much better than a pedometer that you just kind of put in your pocket. I wish there different functions. Like I said, the ones I didn't use. I don't know what would make it more interesting, but to me it just felt like a glorified pedometer. It could be other things."(FB02) "So being able to track calories was really cool. (FB08)

Table 30. Product Centered Factors (Continued)

System Quality (SQ)	Usage of Code	%	Related System Characteristics (Number of comments)	Strongly Related SQ	Example User Comments
			[36] Price of the device /system [26] Usage of battery life [18]		
Social experience	Fits with perceived social norms	8.77	Interaction Sharing visual data with friends [102] Sharing all data with others (online)[20] Usage – Visual Sharing experience of device [393] Usage of whole system [41] Usage of online system [16]	• Meaningful data / interactions • Pleasing aesthetics • Privacy	"Well, I showed the device to couple of my friends… I mentioned that it's so cool that I can like track my own stuff over days and such, but that's all. They thought it was very cool." (FB05)
Ease of Interaction	Interaction being easily understandable and make the interaction possible	8.21	Interaction Learning calorie intake data [67] Learning about self-all data [54] Synching data [24] Usage Usage of online system [90] Usage of device itself [81] Usage of application only [60] Usage of whole system [46]	• Usefulness • Meaningful data / interactions	"Yeah, I talked about the data presentation. So I just wish that more of the stuff that's online was available in the iPhone device." (BM05)
Pleasure in use	Enabling enjoyable experiences while using the product/system	6.47	Interaction Interacting with device [68] Interacting with online system [41] Interacting with self-all data [29] Learning about sleep data [15] Interaction - Visual	• Meaningful data / interactions • Ease of interaction • Pleasing aesthetics	"That was the best part, I thought, about the whole thing. The graph and calories burned over time, and it is eye-opening seeing your data recorded so religiously over time." (BM05)

Table 30. Product Centered Factors (Continued)

System Quality (SQ)	Usage of Code	%	Related System Characteristics (Number of comments)	Strongly Related SQ	Example User Comments
			Interacting with visual representation (flower) [29] Usage Usage of whole system [30]		
Smartness	Acting in response to user's needs	3.86	Interaction Giving suggestions [39] Learning about sleep data [21] Learning about self-all data [16] Usage Device having smart features [44] System having smart features [19]	• Personalization • Ease of interaction • Meaningful data / interactions • Accuracy	"And I would be really curious to see in a situation where it knows all my data as well as it can. It takes all of its measurements and like I guess, I will have to tell it while I eat."(FB04)
Accuracy	Collecting and showing data accurately	3.70	Usage Accuracy of device' measurements [40] Accuracy of activity data [36] Accuracy of number of steps [26] Accuracy of self-all data [23] Accuracy of calorie intake data [19] Accuracy of calories burned [18]	• Meaningful data / interactions • Usefulness	"Well, I'm not sure which we're measuring for movements at night. I mean that was a little bit strange." (FB05) And there are times that I'd be at the gym, thinking I'm dying and it tells me I only did 7 minutes of vigourous activity. So I don't know if it's just based on heart rate maybe and that's what it estimating on." (BM06)
Pleasing aesthetics	Having appealing visual characteristics	2.99	Visual Aesthetics of the device [135] Aesthetics of the online system [48] Color of the device [14]	• Comfort in mobility • Social experience	"On a different part of my body that wasn't so visible... If they made it something like really fashionably cool design, maybe I would prefer it. That would eliminate a lot of the social anxiety stuff."(BM05)
Personalization	Being able to	2.84	Usage	• Meaningful	"Like this coach who knows or maybe who sets your

Table 30. Product Centered Factors (Continued)

System Quality (SQ)	Usage of Code	%	Related System Characteristics (Number of comments)	Strongly Related SQ	Example User Comments
	make the data/ device/ system personalized to fit the specific user needs		Personalization of suggestions [51] Online system being adaptive to the user [22] Device being adaptive to the user [17] Personalization of all data [15]	data / interactions • Pleasing aesthetics	goals and actively monitors your progress and encourage you. Not yelling at you. [...]" (FB06)
Comfort in mobility	Availability to carry everywhere. Being comfortable to use when the product is on body	2.74	Usage Comfort of device [180]	• Usefulness • Pleasing aesthetics	"There were a couple of times when I had it on where it was either too loose and it wouldn't get data. So I found myself a few times having to put it back where it was supposed to be or tightening it." (BM08)
Ease of communication	Offering understandable interactions	2.59	Usage Communication with the device [84] Communication with the online system [36] Communication of whole system [19] Interaction - Visual Interacting with visual representation (flower) [14]	• Usefulness • Ease of interaction • Pleasing aesthetics	"I wish it all like updated automatically which I mean that's like hard to do or even if you got maybe like close to your phone, it could like bump information. I don't know." (FB08) "[…] because sometimes when I put in on, it wouldn't beep for five minutes to let me know I was wearing it right" (BM09)
Compactness	Being tidy and compact. not having unnecessary parts/elements	2.59	Visual Compactness of the device [65]	• Pleasing aesthetics	"I think it's a very attractive device. I think that it's not too big, we're strictly looking at how it looks then I think it looks fine."(BM07)
Systematic design	Having the same interaction	0.86	Interaction – Visual Consistency of all system [20]	• Meaningful data /	"And then, it's interesting, because some things are on the phone, but some things are on the computer"

Table 30. Product Centered Factors (Continued)

System Quality (SQ)	Usage of Code	%	Related System Characteristics (Number of comments)	Strongly Related SQ	Example User Comments
	language within the different elements of system		Consistency of all data presentation [17]	interactions • Pleasing aesthetics	(BM03)
Privacy	Keeping the information personal/social	0.69	Usage- Visual - Interaction Sharing data with others [24]	• Social experience	"I didn't share my data because personally, I'm against sharing. (FB06)
Customization	Giving the opportunity to customize the product/system	0.33	*[26 comments in total]*		
Context Awareness	Being aware of the context and acting accordingly	0.33	*[23 comments in total]*		
Simplicity	Having characteristics that make the form and usage simple	0.18	*[15 comments in total]*		

Table 31. Human Centered Factors (Continued)

System Quality (SQ)	***Usage of Code***	***%***	***Related System Characteristics (Number of comments)***	***Strongly Related SQ***	***Example Participant Comments***
Motivation	People's being motivated by the system and their inner motivation helped	8.52	Interaction Showing goal achievements / goals [74] Learning activity data [54] Giving suggestions [50] Having reminders [28] Showing rewards [19] Learning calorie intake data [15] Usage Using the device itself [95] Usage of whole system [28] Usage of online system [22]	Meaningful data Smartness Personalization	"The level of motivation and the excitement that I've had using the Fitbit, I mean the difference is practically overnight." (FB03) "Maybe like an alert to remind you to get up and move every so often, something like that to motivate you to just not sit there the whole time." (BM06)
Curiosity	People's being curious to check their data	3.37	Interaction Interaction with device [44] Learning about all personal data [35] Learning activity data [32] Usage Using the device itself [17]	Meaningful data Personalization	"Because, like I said in the beginning, it was a new product. So you just are so curious, but you kind of learn, you kind of then know. [After a while] you really don't have to check it because you know. If you're doing the same thing every day, you start to know what it's going to say." (FB02)
Engage	People's being engaged with the system	2.90	Interaction Learning calorie intake data [17] Giving suggestions [14] Learning activity data [13]	Meaningful data Personalization	"When it doesn't work, that was the most frustrating when it wouldn't upload the data. Like the software wasn't working. We spent an hour doing that." (BM05) "They did not do that, so I was disappointed, all becomes tedious to get to the data I want."(BM07)
Realization	The things that people realize about themselves	2.38	Interaction Learning sleep data [33]	Usefulness Meaningful data	"I've just realized how important food intake is." (FB01)

Table 31. Human Centered Factors (Continued)

System Quality (SQ)	*Usage of Code*	*%*	*Related System Characteristics (Number of comments)*	*Strongly Related SQ*	*Example Participant Comments*
			Learning activity data [29] Learning calories taken [15] Learning calories burned [14]	Personalization	"So a couple of times I've looked at it and it said three minutes. That's amazing." (FB03)
Feel good	The way people feel good as a result of using the system	2.15	Interaction Learning about self [17] Usage Using the device itself [65] Usage of whole system [22]	Usefulness	"It was good because I lost weight. I was losing weight and that was good." (BM02) "It's more the results that make me feel good." (FB03)
Behavior change	The way people's behaviors change during the study	1.96	Interaction Interaction with device [44] Learning calorie intake data [35] Learning activity data [30]	Usefulness Meaningful data Personalization	"Because now I anticipate that you would feel sort of responsible to the system... I guess some of the ways to improve that would be having these other signals that you're getting whether it's the sound or whether it's seeing the flower on the device." (FB06)
Awareness	The things that people become aware of themselves	1.48	Interaction Learning activity data [24] Learning calories burned [16] Learning sleep data [13] Learning calorie intake data [13]	Meaningful data Personalization	"So I became aware of my day to day activities. Most of the time, I found myself checking the data to see if I'm doing well for that day or not."(FB06)
Excitement	People's feeling excitement to use the system	1.09	Usage Using the device itself [42] Usage of whole system [13]	Usefulness	It's kind of like a school when at first, first week of class is exciting because it's new. Then once you're in there you're like, I just want it to end. (FB02)
Interest	People's interest in using the system	0.92	Interaction Learning sleep data [13] Usage Using the device itself [22]	Usefulness Meaningful data	"Most of the time, I found myself checking the data to see if I'm doing well for that day or not."(FB06)
Habitualization of usages	The way the system becomes a habit to use the	0.89	Usage Using the device itself [13]	Usefulness Meaningful data	"Because it became kind of like a habit. It was very -- I'm trying to think of the right word. It

Table 31. Human Centered Factors (Continued)

System Quality (SQ)	***Usage of Code***	***%***	***Related System Characteristics (Number of comments)***	***Strongly Related SQ***	***Example Participant Comments***
	system		Interaction Learning about all data [21] Learning calorie intake data [13]		didn't motivate me... So it was kind of external of this." (FB01)
Annoying	The things that people feel annoyed about the system	0.63	*[30 comments in total]*		
Disappointment	The things that creates disappointment	0.14	*[7 comments in total]*		

Table 32. Anova Results of Survey Questions

ANOVA						
		SS	df	MS	F	Sig.
Functions well	Between Groups	3.967	1	3.967	2.083	.156
	Within Groups	87.636	46	1.905		
	Total	91.604	47			
Makes me feel good	Between Groups	1.281	1	1.281	.738	.395
	Within Groups	79.851	46	1.736		
	Total	81.131	47			
Affects my social life positively	Between Groups	.827	1	.827	.678	.415
	Within Groups	56.114	46	1.220		
	Total	56.941	47			
Is aesthetically pleasing	Between Groups	18.278	1	18.278	10.293	**.002**
	Within Groups	81.689	46	1.776		
	Total	99.967	47			
Communicates with me well	Between Groups	5.254	1	5.254	3.070	**.086**
	Within Groups	78.726	46	1.711		
	Total	83.980	47			
Motivates me	Between Groups	.992	1	.992	.245	.623
	Within Groups	186.333	46	4.051		
	Total	187.325	47			
Keeps me curious about the data	Between Groups	1.892	1	1.892	.593	.445
	Within Groups	146.889	46	3.193		
	Total	148.781	47			
Is rich in terms of interaction	Between Groups	1.491	1	1.491	.790	.379
	Within Groups	86.816	46	1.887		
	Total	88.307	47			

Table 33. Correlations of Survey Questions

		Engaging in terms of experience	Functions well	Makes me feel good	Affects my social life positively	Is aesthetically nleasing	Communicates with me well	Motivates me	Keeps me curious about the data	Is rich in terms of interaction
Engaging	Pearson Correlation	1	**.47****	**.76****	**.72****	.17	**.66****	**.78****	**.63****	**.70****
	Sig. (2-tailed)		.00	.00	.00	.26	.00	.00	.00	.00
	N	48	48	48	48	48	48	48	48	48
Functions well	Pearson Correlation	**.47****	1	**.71****	**.49****	**.32***	**.83****	**.59****	**.59****	**.74****
	Sig. (2-tailed)	.00		.00	.00	.03	.00	.00	.000	.00
	N	48	48	48	48	48	48	48	48	48
Makes me feel good	Pearson Correlation	**.76****	**.71****	1	**.68****	.17	**.78****	**.89****	**.74****	**.82****
	Sig. (2-tailed)	.00	.00		.00	.26	.00	.00	.00	.00
	N	48	48	48	48	48	48	48	48	48
Affects my social life positively	Pearson Correlation	**.72****	**.49****	**.68****	1	**.35***	**.51****	**.61****	**.52****	**.64****
	Sig. (2-tailed)	.000	.000	.000		.01	.00	.00	.00	.00
	N	48	48	48	48	48	48	48	48	48
Is aesthetically pleasing	Pearson Correlation	.16	.32*	.17	**.35***	1	.26	.02	.00	.17
	Sig. (2-tailed)	.26	.03	.26	.01		.07	.90	.98	.25
	N	48	48	48	48	48	48	48	48	48
Communicates with me well	Pearson Correlation	**.66****	**.83****	**.78****	**.51****	.26	1	**.74****	**.65****	**.85****
	Sig. (2-tailed)	.00	.00	.00	.00	.07		.00	.00	.00
	N	48	48	48	48	48	48	48	48	48
Motivates me	Pearson Correlation	**.78****	**.59****	**.89****	**.61****	.02	**.74****	1	**.82****	**.75****
	Sig. (2-tailed)	.00	.00	.00	.00	.80	.00		.00	.00
	N	48	48	48	48	48	48	48	48	48
Keeps me curious about the data	Pearson Correlation	**.63****	**.58****	**.74****	**.51****	.00	**.65****	**.82****	1	**.68****
	Sig. (2-tailed)	.00	.00	.00	.00	.98	.00	.00		.00
	N	48	48	48	48	48	48	48	48	48
Is rich in terms of interaction	Pearson Correlation	**.70****	**.74****	**.82****	**.64****	.17	**.83****	**.75****	**.68****	1
	Sig. (2-tailed)	.00	.00	.00	.00	.25	.00	.00	.00	
	N	48	48	48	48	48	48	48	48	48

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

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

APPENDIX K:

CURRICULUM VITAE

ARMAĞAN KURU (KARAHANOĞLU) Research Assistant at Dept. of Industrial Design
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EDUCATION

Doctorate of Philosophy, February, 2013, Middle East Technical University
Department of Industrial Design
Thesis Subject: Exploration of User Experience of Personal Informatics Systems
Advisor: Çiğdem Erbuğ, GPA: 4.00

Fulbright Visiting PhD Student, Carnegie Mellon University
Human Computer Interaction Institute
Advisors: Jodi Forlizzi, Dan Siewiorek

Master of Science, July 2008, Middle East Technical University
Department of Industrial Design
Thesis Title: A study of consumers' emotional responses towards brands and branded products
Advisor: Bahar Şener-Pedgley, GPA: 3.81

Bachelor of Industrial Design, June 2005, Middle East Technical University
Dept. of Industrial Design
Graduation project: Counter top Sink for Toprak Seramik
GPA: 3.05

RESEARCH EXPERIENCE

Middle East Technical University, BILTIR UTEST Product Usability Unit
Researcher, since June 2008
Working in several projects, as interviewee and data analyst
Projects include:
Benchmarking in Dishwasher Usage, *December 2010-March 2011*
Exploring Behavior Changes in Dishwasher Usage, *June-August 2010*
Perceived Qualities in Minibuses, *June 2008 – April 2009*

Carnegie Mellon University, Human Computer Interaction Institute
Visiting Researcher, September 2011-July 2012
Worked as the main researcher, project developer, interviewee and data analyst of a study
Project: Engaging Experience of Personal Informatics Systems

EDUCATIONAL EXPERIENCE

Department of Industrial Design, METU, Ankara, Turkey
Research Assistant *of Courses:*
ID101 Basic Design I (2008-2009/2009-2010/2010-2011/ 2012-2013)
ID102 Basic Design II (2006-2007 / 2008-2009 / 2009-2010/2010-2011)
ID301/302 Industrial Design III-IV (2007-2008)
ID311 Computers in Design (2007-2008)
ID495 Portfolio Presentation (2007-2008/2008-2009/ 2009-2010)
ID706 Design Methods (2008-2009)
ID531 Models and Methods of Ergonomics (2009-2010 / 2012-2013)
(Lectures on Scientific Research, User Experience and Persuasive Design)

ID719 Dimensions of Design for Emotion (2010-2011/ 2012-2013)
(Lectures on User Experience and Persuasive Design)

WORK EXPERIENCE

Middle East Technical University, Department of Industrial Design
Research Assistant, Ongoing since November 2006

Middle East Technical University, Department of Industrial Design
Senior Researcher, Ongoing since June 2008

Carnegie Mellon University, Human Computer Interaction Institute
Visiting Researcher, September 2011-July 2012

Motali Technological Systems A.S., Department of Research and Development
Industrial Designer, July 2005- November 2006

INTERNSHIPS

Tsrm12 Design Office
Intern Industrial Designer, Summer 2004, 4 weeks

Graphic Design Department, METU Rectorate
Intern Graphic Designer, Summer 2004, 2 weeks

TRT, Artistic Services Department
Intern TV Stage Designer, Summer 2004, 4 weeks

Arçelik Washing Machine Management
Intern Industrial Designer**,** Summer 2003, 4 weeks

Department of Industrial Design, METU
Intern Design Student, Summer 2003, 2 weeks

Department of Industrial Design, METU
Intern Design Student, Summer 2002, 6 weeks

FUNDINGS

Turkish Fulbright Commission
Visiting PhD Researcher Scholar, September 2011-July 2012

National Science Foundation (NSF-USA)
Project Funded through Jodi Forlizzi & Dan Siewiorek, January-May 2012

TUBITAK (Scientific and Research Council of Turkey)
Financial Support, PhD Researcher Scholar, 2008-Ongoing

METU, Faculty of Architecture
Financial Support by for International Conference Participation, 2011

TUBITAK (Scientific and Research Council of Turkey)
Financial Support by for International Conference Participation, 2009

PUBLICATIONS

Kuru,A, Forlizzi, J & Siewiorek, D. Engaging experience of personal informatics systems. Unpublished Paper

Kuru,A & Erbuğ C. (2012). Explorations of perceived qualities of on-body interactive products. Submitted to Ergonomics, preparing for second review.

Turhan, M. & **Kuru**, A. (2012) Kullanıcı ve görev özelliklerine göre kullanilabilirlik testinin etkenleri hakkında bir araştırma. *18. Ulusal Ergonomi Kongresi Bildirileri, Kasım, 16-18 2012, Gaziantep, Turkey*

Karahanoğlu, A. & Erbuğ, C. (2011) Perceived qualities of smart wearables: determinants of user acceptance. *Proceedings of 5th International Conference on Designing Pleasurable Products and Interfaces. 22-25 June 2011, Milan, Italy.*

Turhan, M. & **Karahanoğlu**, A. (2011) Understanding Usability Dimensions in relation to User Characteristics and Task Depth. *Presentation at TestIstanbul , May 26-27 2011, Istanbul, Turkey*

Karahanoğlu, A. & Şener-Pedgley, B. (2009) Consumers' Emotional Responses to Brands and Branded Products. Paper presented in Third International Conference on Design Principles and Practices, on 17th of February 2009 in Berlin, Germany.

Karahanoğlu, A. & Şener-Pedgley B. (2009) *Consumers' emotional responses to brands and branded products.* Published in Design Principles and Practices, An international Journal, Vol3

WORKSHOPS

Jump Start to Design Research – TU Delft, Netherlands
Researcher, 07 July 2008 – 11 July 2008

EXHIBITIONS

Istanbul Furniture Fair, Istanbul, Turkey
19 April 2006–23 April 2006, CNR Expo Center
Denini and Seray Furniture Stands

Milano Furniture Fair, Milan, Italy
05 April 2006–10 April 2006, Fieramilano
Denini and Seray Furniture Stands

Dubai Index Fair, Dubai
28 November - 02 December 2005,
Dubai International Exhibition Center, Seray Furniture Stand

1st Mediterranean Kitchen, Bathroom and Sanitary Fair, Antalya, Turkey
29 September - 02 October 2005,
Antalya Expo Center – METU Department of Industrial Design Stand

Graduation Projects Exhibition, Ankara, Turkey
30 May- 01 June 2005, METU Cultural and Convention Center
Department of Industrial Design Stand

PRIZES

IMMIB2007- Plastic House ware Products Category (Professional)
Honorable Mention (With Senem Tural)

ACHIEVEMENTS

Graduated as Honor Student
2004-2005 High Honor Student; Spring Semester
2004-2005 Honor Student; Fall Semester
2003-2004 Honor Student; Spring and Fall Semesters

LANGUAGES

Turkish – Native
English - Fluent
Spanish - Intermediate (Ankara University, TÖMER, Language Diploma 2005)
