SUSTAINABILITY CONSIDERATIONS ON EFFECTIVE USE OF RESOURCES FOR SMALL HOUSEHOLD APPLIANCES

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submitted by **DİLRUBA OĞUR** in partial fulfillment of the requirements for the degree of **Master of Science in Industrial Design Department, Middle East Technical University** by,

Prof. Dr. Canan Özgen
Dean, Graduate School of **Natural and Applied Sciences** _____

Prof. Dr. Gülay Hasdoğan
Head of Department, **Industrial Design** _____

Assist. Prof Dr. Çağla Doğan
Supervisor, **Industrial Design Dept., METU** _____

Examining Committee Members:

Prof. Dr. Gülay Hasdoğan
Industrial Design Dept., METU _____

Assist. Prof. Dr. Çağla Doğan
Industrial Design Dept., METU _____

Assist. Prof. Dr. Harun Kaygan
Industrial Design Dept., METU _____

Assist. Prof. Dr. Naz Börekçi
Industrial Design Dept., METU _____

Dr. Senem Turhan _____

Date: September 3, 2014

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Dilruba Oğur

Signature :

ABSTRACT

SUSTAINABILITY CONSIDERATIONS ON EFFECTIVE USE OF RESOURCES FOR SMALL HOUSEHOLD APPLIANCES

Oğur, Dilruba
M.S., Department of Industrial Design
Supervisor: Assist. Prof. Dr. Çağla Doğan

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The use phase of many products' lifecycle has significant impacts on the environment that are largely determined by the use behaviour. Yet, those impacts mostly remain unnoticed, since individuals are unaware of the potential environmental consequences of their everyday practices and interactions with products, and have insufficient means to find them out. This study explores and examines use patterns and behaviours throughout the use phase of the small household appliances, particularly electric tea makers and contact grills, with an emphasis on effective use of resources, and incorporates this knowledge for the development of sustainability considerations. In this regard, the study adopts a user-centred research approach and includes a series of user observations, interviews and generative focus group sessions to have a comprehensive understanding of the problem areas for effective use of resources. The conclusions and insights from the study contribute to the development of sustainability considerations and design directions for reducing resource consumption during the use phase of household appliances. The results of the study also suggest a new design strategy, namely eco-

engage, for incorporating these considerations into product design for sustainability.

Keywords: Sustainable Consumption, Effective Use of Resources, User-centred Research, Design for Sustainable Behaviour

ÖZ

KÜÇÜK EV ALETLERİ İÇİN KAYNAKLARIN VERİMLİ KULLANIMINA YÖNELİK SÜRDÜRÜLEBİLİRLİK ÖLÇÜTLERİ

Oğur, Dilruba
Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü
Tez Yöneticisi: Yrd. Doç. Dr. Çağla Doğan

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Birçok ürünün yaşam döngüsündeki kullanım aşamasının, çevre üzerinde önemli etkileri vardır ve bunlar büyük ölçüde kullanıcı davranışlarından kaynaklanır. Ancak, kullanıcılar gündelik pratiklerinin ve ürünlerle etkileşimlerinin olası çevresel sonuçlarından habersiz oldukları ve bu konuda bilgi sahibi olmak için yeterli araçlara sahip olmadıklarından, bu etkiler çoğunlukla fark edilmemektedir. Bu çalışma küçük elektrikli ev aletlerinin, özellikle elektrikli çay makinelerinin ve ızgara/tost makinelerinin, kullanım aşamasında gerçekleşen kullanıcı davranışlarını, kaynakların verimli kullanımı açısından inceler ve bu bilgiyi sürdürülebilirlik ölçütlerinin geliştirilmesi için kullanır. Bu bağlamda, çalışma kullanıcı odaklı bir araştırma yöntemi benimser ve kaynakların verimli kullanımına yönelik problem alanlarının kapsamlı bir şekilde anlaşılabilmesi için bir dizi kullanıcı gözlemleri, görüşmeler ve yaratıcı odak grubu oturumları içerir. Çalışmadan elde edilen sonuçlar ve çıkarımlar elektrikli ev aletlerinin kullanım aşamasındaki kaynak tüketimini azaltmaya yönelik sürdürülebilirlik ölçütlerinin ve tasarım yönergelerinin geliştirilmesine katkı sağlar. Aynı zamanda, çalışmanın sonuçları bu ölçütlerin sürdürülebilirlik için tasarım

sürecine dahil edilebilmesi için ekolojik-bağlanma (eco-engage) olarak adlandırılan yeni bir strateji önerir.

Anahtar Kelimeler: Sürdürülebilir Tüketim, Kaynakların Verimli Tüketimi, Kullanıcı Odaklı Araştırma, Sürdürülebilir Davranış için Tasarım

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To My Family

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CHAPTER 1

INTRODUCTION

> "The changing environment of our fragile planet is a result of the things that we do and the tools that we use. Now that the changes that we have brought about are so major and so threatening it is imperative that designers and architects play their part in helping to find solutions."
>
> Papanek, 1995, p.8

It is widely acknowledged that current norms of production and consumption patterns have led to significant problems and affected the world at the global scale. Environmental problems arising from these patterns including climate change, pollution and resource depletion along with the social problems related to health, poverty and inequity have gained importance in the global consciousness. Considering these issues in the long run, the World Commission on Environment and Development (1987, p.43) defined the term sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Later the approach has been adopted by many researchers within a wide range of disciplines including product design to positively contribute to the three main principles of sustainability (i.e. environmental, economic and social). Even though the notion of sustainability is commonly defined in terms of this triple bottom line, many suggested a fourth element for a more comprehensive definition. In this regard, Walker (2011) proposes "personal meaning" as the fourth dimension to the quadruple bottom line for sustainability, considering the significance of the sustainability at an individual level. Within the design inquiry, sustainable development has fostered various perspectives over the past

two decades to effectively address the environmental, economic and social aspects enacted throughout the whole product lifespan. However, these approaches have been dominated by rethinking and reducing the impacts of production and disposal of products, whereas the implications of product use have been considered less.

There is an ecological dimension of all human practices, for instance, turning the light on to read a book, cooking meals for the family or turning up the heating for elderly, all of which have consequences for the environment. For many energy-using products (e.g. white goods, lighting, household appliances, etc.), the most significant environmental impacts occur during the use phase of product lifespan, and these are largely determined by use behaviour (Lockton, 2013; Bhamra & Lofthouse, 2007; Rodriguez & Boks, 2005). Many household products, for example mini ovens and televisions, may not be completely switched off, but continually consume energy in a stand-by mode that is responsible for excessive energy consumption. Similarly, overfilling the kettle, for instance, may cause %89 increase in energy consumption to boil a litre of water (Elias, Dekoninck & Culley, 2009). Yet, those impacts mostly remain unnoticed, since individuals are unaware of the potential environmental consequences (i.e. water scarcity, air pollution, etc.) of their everyday practices and interactions with products, and have insufficient means to find them out. With respect to this, in order to encourage users to adopt sustainable consumption patterns and reduce resource consumption accordingly, the mutual relation between the use behaviour and its environmental consequences should be reinforced.

The design of products and services has a profound and direct influence on individual behaviours, as well as on the environment and society. Accordingly, research on the implications of design for user behaviour has gained importance for the development of new products and services. Design for Sustainable Behaviour (DfSB) is emerging as a research area at the intersection of sustainable design and interaction design. It garners insights from multiple disciplines to rethink and reduce negative impacts of product use through identifying intervention strategies to be incorporated into a design context.

(Lockton, 2013; Elias et al., 2009; Wever, van Kuijk & Boks, 2008; Lilley, Lofthouse & Bhamra, 2005). In this regard, DfSB is a promising approach to influence users towards sustainable consumption patterns in the use phase of products.

The world has witnessed a significant increase in energy and water consumption during the past few decades. Consequently, resource effectiveness and increasing utilisation of renewable resources (e.g. solar energy, wind power, hydropower, geothermal, etc.) have gained importance for sustainable development. In Turkey, water scarcity is one of the concerns in this area as the "availability of water per capita per year in Turkey is only about one fifth of that of the water rich countries" (DSI, 2009, p.2) and it is decreasing rapidly. Along with this, Turkey's energy demand has increased significantly over the past few decades and is estimated to grow further (Toklu, 2012). Despite Turkey's huge potentials for producing renewable energy, its energy demand mainly depends on non-renewable energy sources (e.g. oil, gas, coal, etc.) that are largely imported with a rate of 72% (EEA, 2011). Domestic electricity consumption is one of the significant contributors to energy demand that accounts for the 25% of the total electricity consumption of Turkey (Dilaver & Hunt, 2010). Household electrical appliances, for instance, have enabled easier and more convenient lifestyles while consuming massive amount of energy that is not visible to the conventional consumption patterns. The average electricity consumption by household cooking appliances such as ovens, kettles and grills are responsible for the %13.8 of the total domestic energy consumption (Energy Saving Trust, 2012). As new technologies are introduced, the household appliances have become increasingly water and energy efficient (e.g. eco-efficient modes on washing machines, etc.), yet such technological improvements have not necessarily turned into energy savings during the use stage (Lidman & Renström, 2013). This reveals that individual behaviours are responsible for a significant proportion of the overall resource use of the products and thus, reducing domestic resource consumption (i.e. electricity and water) that has been a prominent social challenge, requires an understanding of product-led as well as user-led concerns.

There are a few research studies that show the importance of user-centred research in comprehending individuals' egagement and interaction with products and providing insights to influence sustainable patterns of use through redesign (Lockton, 2013). In this regard, through comprehending individuals' routines, their motivations and experiences with products in real-life contexts, it can be possible to identify use patterns leading to excessive and/or intensive resource consumption, and explore design directions for effective use of resources.

1.1. Aim and Objectives of the Study

Considering the significance of use behaviour for the environmental implications of product use, this thesis aims to explore individuals' experiences with small household appliances (contact grills and electric tea makers in particular) in order to have a comprehensive understanding of the problem areas considering the effective use of resources, and incorporate this knowledge and insights for the development of sustainability considerations. This research includes the following purposes:

- exploring and evaluating existing research studies, approaches and design-led interventions which attempt to influence user behaviours towards a reduction in environmental impacts of product use *(literature search)*;
- exploring the use patterns of small household appliances in terms of effective use of resources to identify problem areas and sustainability considerations *(user observations and interviews)*;
- developing and assessing sustainability considerations further through facilitating generative sessions with users *(focus group sessions)*; and
- exploring potential design directions in line with the problem areas on effective use of resources.

In order to achieve that, the current research explored use behaviours in real-life contexts through series of user observations and interviews with particular small household appliance users, and generative sessions to complement the findings of the research studies.

1.2. Research Questions

The main research question that this study aims to address is:

- What are the main sustainability considerations regarding effective use of resources in the use phase of small household appliances (particularly electric tea makers and contact grills), and what are the implications of these for product design for sustainability?

The secondary research questions are:

- What are the significant issues leading to excessive and/or intensive resource consumption in the use phase of electric tea makers and contact grills?
- What are the potential solution areas and design directions to achieve effective use of resources within the use phase of products?

1.3. Structure of the Thesis

This thesis consists of six chapters:

This first chapter presents the problem statement, aim and objectives of the research along with the research questions through a brief introduction.

Chapter 2 provides a comprehensive overview of the literature that is relevant to the aim and scope of the research being undertaken for a better understanding of the background of the research problem. It includes the review of approaches towards sustainable consumption and particularly design for behaviour change through discussing their implications for product design for sustainability. It also discusses the importance of user-centred research for a detailed understanding of domestic resource consumption through reviewing existing research studies in this area.

Chapter 3 explains the methodological approach adopted throughout this research and presents a comprehensive overview of the research process including data collection methods, the development of the interview and focus group guideline, access to participants, data analysis methods along with its limitations.

Chapter 4 starts with the results of the *preliminary study* that aims to revise and refine the interview guideline for the further phases of the study. The chapter mainly

focuses on the *primary research I: user observations on various household appliances,* which includes eight user observations and semi-structured interviews carried out in domestic settings to explore the use phases and use behaviours around electric household appliances (i.e. *contact grill, Turkish coffee maker, mini oven, electric tea maker, bread maker, electric frying pan, steam generator iron and air humidifier*) to better comprehend the patterns that lead to excessive resource consumption. It concludes with the cross comparison of the findings from the product cases in line with the emerging sustainability considerations.

Chapter 5 presents the findings from and insights into the *primary research IIA: user observations on electric tea makers and contact grills*, which aims to identify the problem areas and potential design directions for effective use of resources further through exploring the behaviours in using these products. It also complements and supports the findings of the previous stages of the research through presenting the results of the *primary research IIB: generative focus group sessions* facilitated with the product users.

Chapter 6 presents the overall conclusions from and insights into the research studies through revisiting the research questions, and discusses the implications of this research for product design, and its limitations along with the recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

> "The sustainability crisis is a behavioral issue, and not one simply of technology, production and volume."
>
> Chapman, 2009, p.29

This chapter presents a comprehensive overview of the literature that is relevant to the aim and scope of the research being undertaken. Firstly, the emergence of the sustainable development along with the notion of sustainable consumption and its various approaches within the context of product design for sustainability will be explored. Later, design for behaviour change and its approaches will be explained and presented through the product-led interventions. Finally, the importance of user-centred research for a detailed understanding of domestic resource consumption will be explained through overviewing existing research studies.

2.1. Introduction

Nature is struggling to sustain the individuals' exploitative consumption of its resources and to absorb the consequences of humankind's intensive production and consumption practices. As reported by World Wide Fund of Nature (WWF) in 2012, individuals' annual demands from the Earth have been exceeding its productive capabilities by 50 per cent. This implies that it takes one and a half year for the nature to regenerate the renewable resources consumed and absorb the waste generated as a result of these practices within a year. Considering the growing increase in human population, and the irrepressible rise in consumption to improve the quality of life, the threat to the global ecological stability and diversity is

extremely serious.

Individuals' consumption patterns vary significantly based on a number of factors, for instance, their access to the natural resources, legislations and regulations employed within the different populations or socio-economic instability, all of which influence the consumption norms noticeably. 80% of the world population with low income still has problems to maintain a quality of life as a consequence of the socio-economic structure of their society, and live with the absence of or limited access to very basic human needs (i.e. food, water, housing and sanitation). The remaining %20 of the population, on the other hand, depletes the most of the world resources (%87), which involves considerable amount of raw materials, products, energy consumption and waste (Fussler & James, 1996). It is roughly estimated that unless we change these patterns, even two planets will not be enough to support our demands by 2030 (WWF, 2012).

It is apparent that the intensive consumption patterns of the minority have been affecting the world at the global scale (e.g. depletion of non-renewable resources, carbon emission, water shortage, pollution, etc.) and creating problems for the society as well as for the future generations (Fuad-Luke, 2009). Therefore, it is essential that humankind needs to change its perception about the natural capital as a limited resource in the world, and perform environmentally responsible patterns to contribute to the wellbeing of the future (Fuad-Luke, 2009).

Considering the life threatening impacts in the long run, the term sustainable development, which aims to fulfil the needs of the world without destroying the possibilities for the future generations worldwide, has been manifested by World Commission on Environment and Development (WCED) in 1987. Realising that the wellbeing of future is at great risk, this approach has gained attention from the late 1980s onwards, and has been adopted within a wide range of disciplines from different perspectives along with the area of product design.

2.2. Sustainable Consumption and Related Approaches

Within the design inquiry sustainable development has fostered various perspectives and methods over the past few decades to effectively address the environmental,

economic and social aspects enacted throughout the product lifespan. Within the scope of this study, effective use of resources (i.e. energy and water) during the use phase of the small household appliances has been the main consideration. Thus, various sustainability approaches with an emphasis on consumption patterns will be explained further.

It appears that our current consumption patterns are unsustainable. Climate change, resource depletion and instability of the ecosystem are all consequences of these practices. Consumption comprises of several stages including selection, purchasing, use, maintenance, repair, and disposal and recycling of products and services (Koskijoki, 2007). Considering the each phase of this process, sustainable consumption aims to generate responsible and effective routines of use, and make changes on the products to increase product lifespan as well as to encourage responsible purchasing, use and post-use behaviours. It is not simply consuming less but consuming differently in an effective way.

Even though the consumption patterns and use behaviours are widely determined by users, design has the potential to lead users towards sustainable consumption patterns as well. In this regard, product design needs to revaluate its potential and responsibilities to encourage sustainable consumption patterns for the purpose of contributing positively to the aspects of sustainable development.

Following sections present approaches focusing on the notion of sustainable consumption from different viewpoints, all of which, however, have the common goal that is reducing the life-threatening consequences of the current consumption practices.

2.2.1. Eternally Yours

Rapid disposal of products as a result of the current production and consumption system damages the environment through generating waste and increasing resource consumption. Eternally Yours is an approach addressing the concerns related to the products that are designed with short lifespans and disposed rapidly, even when they are still in good condition and function properly (Verbeek & Kockelkoren, 1998). It suggests four potential directions towards sustainable development including shifting

from products to services, eco-design, recycling and finally extending the product lifespan, which is the prominent concern of this approach (Verbeek & Kockelkoren, 1998). Products are discarded as a consequence of the technical, economical and psychological obsolescence such as being broken down, the emergence of new products and not fitting to the rapidly changing preferences. *Eternally Yours* emphasises the significance of the latter, the personal dimension of longevity, and explores the means of prolonging the psychological lifetime of products (e.g. forms, materials, services, signs and scripts, etc.) through enabling product engagement.

2.2.2. Emotionally Durable Design

Chapman (2005) stresses similar concerns related to the product obsolescence (i.e. functional obsolescence and psychological obsolescence) as a consequence of our current unsustainable material culture, and challenges it with emotionally durable objects and experiences that are designed to be desired for a prolonged time. In this regard, *emotionally durable design* focuses on creating values and meanings through strengthening the bonds between users and products rather than simply designing physically durable products (Chapman, 2009, p.35). It is quite possible with the existing technology to design and manufacture a product that will function properly for decades, however it is relatively challenging to enable the user to keep it and engage with it for a long time. Thus, the approach simply explores how products can remain meaningful and adapt to the changing preferences and needs of users over time with the aim of elongating the products' lifespan.

2.2.3. Slow consumption

Slow consumption is another approach suggesting that longer-lasting products are essential for sustainable consumption. Currently, products have relatively short lifespans as a consequence of the built-in or psychological obsolescence, and they are discarded in an ever-increasing pace. Cooper (2005) defines slow consumption as a process in which the products are used and eventually discarded in a slower rate through increasing their functional (intrinsic) lifespan as providing careful maintenance, repair, upgrading and reuse. However, considering the economic dimension of the approach it is argued that slow consumption might lead to recession

as a result of the reduction in purchasing of short lifespan products unless alternative employment opportunities are provided such as increased maintenance and repair work (Cooper, 2005).

2.2.4. Responsible Consumption

Marchand (2008) defines the notion of responsible consumption as a process that is concerned with reducing the quantity of goods that are consumed as well as selecting environmentally and socially responsible products. The approach suggests that existing product-centred approaches are not sufficient for achieving responsible consumption behaviours. However, a fundamental reduction in current consumption patterns is required which is possible through comprehending the choices, preferences and perspectives of the individuals (Marchand & Walker, 2007).

Products can be discarded, since they do not function properly (functional obsolescence), as well as they simply decrease in value (psychological obsolescence). Considering this, Marchand (2008) explores how design solutions can be integrated into existing objects that are valueless and ready to be discarded, so that the user would desire to keep them for a longer time.

The design explorations developed by Anne Marchand within this perspective investigates new ways of designing enduring objects and enable them to evolve in time through building new connections between objects and contexts (Marchand, 2008). They demonstrate a transition from technologically and/or aesthetically obsolete products to valued, useful and durable objects through creating new context of use, and contribute positively to the sustainable consumption. For instance, through a simple intervention, which involves sewing identical slip covers for old, diverse and valueless chairs, a family of objects with a longer lifespan is created (Figure 2.1). This approach “proposes a different understanding of newness through the transformation and reinvention of objects and their context over time” (Marchand & Walker, 2007, p.4).

Figure 2.1: Chairs with slipcovers by Anne Marchand (reproduced from Marchand, 2008).

2.2.5. Design for Sustainable Behaviour

Sustainable consumption approaches mentioned so far mainly emphasize the significance of product longevity, and suggest various paths to increase product lifespan (e.g. functional durability, emotional durability, evolving products, etc.) with the aim of decreasing the rapid disposal rate of products and the negative consequences of the consumption patterns. Yet, none has addressed the environmental and social impacts emerged throughout the use phase of products. Realising the behavioural contribution to environmental and social problems, research on how design can influence use behaviour is increasingly being considered in the development of new products and services within the last decade. The approach, which will be explained and discussed in detail further (see Section 2.5), focuses on understanding the psychological factors of behavioural change, and identifying intervention strategies to be applied within a design context.

2.3. Resource Consumption

As mentioned earlier, within the past few decades, significant increase in energy and water consumption has been addressed locally and globally. This increase consequently revealed significant environmental (e.g. depletion of non-renewable resources, water scarcity, etc.) and social implications (e.g. unfair allocation and use of resources, etc.). The world's fresh water reserves, for instance, are decreasing consistently as a consequence of the population growth, urbanisation and increasing

demands of the consumers to fulfil their needs (Fuad-Luke, 2009, p.62). Likewise, Turkey faces with water scarcity, and the availability of the water reserves decreases steadily (DSI, 2009). Furthermore, fair allocation of water is another concern, since heavily populated and industrialised regions lack sufficient fresh water (DSI, 2009). Along with these, energy demand in Turkey has increased significantly that is heavily depended on imported non-renewable energy sources (EEA, 2011). Even though it has substantial renewable energy sources, in particular geothermal power, wind, hydropower and solar power, only a small portion of these are utilised in Turkey (Toklu, 2012). Considering the increasing demand and its dependency on imported energy sources, energy effectiveness and development, and use of renewable energy sources are essential for sustainable development.

Domestic energy (%25) and water (%15) consumption are one of the significant contributors to overall resource consumption in Turkey, and these rates are anticipated to increase within the next decades (Dilaver & Hunt, 2010; DSI, 2009). In this regard, effective use of energy as well as water in domestic environments would be necessary so that the next generations would not suffer from their shortages.

It has been revealed by many Life Cycle Assessment (LCA) studies that for many energy-using products (e.g. white goods, lighting, household appliances, etc.), the use phase contributes the most to the environmental impacts of products (Lidman & Renström, 2011; Elias et al, 2009). For instance, the average electricity consumption by household cooking appliances such as ovens, kettles and grills are responsible for the %13.8 of the total domestic energy consumption (Energy Saving Trust, 2012). This reveals that electrical household appliances that enable more convenient lifestyles are responsible for significant amount of resource consumption.

As new technologies have been introduced, products have become increasingly energy and water efficient. For instance, within the last three decades refrigerators and freezers have been reducing their energy use by at least 60% as well as offering eco-efficient modes (Elias et. al, 2009). Similarly, in washing machines these eco-efficient modes contribute significantly to the overall water and energy consumption. However, technological improvements are not necessarily adopted by the users and turned into energy savings during the use stage, which shows that the behaviours and

use patterns are responsible for a significant proportion of the overall resource use of the products. Thus, reducing domestic resource consumption that has been a prominent social challenge, involves technological improvements along with design interventions encouraging sustainable behaviour patterns (Fuad-Luke, 2009).

There are various studies with a focus on resource (particularly energy) effectiveness in products, yet only a few research studies have explored the individual's behaviours and use patterns as a main contributor to the resource consumption, and have probed into the motivations of these patterns related to the excessive resource consumption. Considering the issues related to water and energy consumption globally and locally and individuals' significant influence on domestic resource consumption and related environmental implications, this specific area of research is considered valuable to explore further. In this respect, resource consumption (i.e. water and electricity) within the use phase of small household appliances will be the main concern throughout this study.

2.4. Challenges to Effective Use of Resources

Considering the importance of use behaviours within the context of resource effectiveness, it is essential to identify the aspects that may be preventing sustainable use behaviours to be adopted.

2.4.1. Invisible Nature of Energy

Technological developments have contributed to the quality of life through enabling easier and convenient lifestyles as well as leading to unsustainable use of resources and having negative implications on the environment and society. Yet, those impacts mostly remain unnoticed, since individuals are unaware of the potential environmental consequences of their everyday interactions with products.

There is a considerable gap between individuals' everyday practices and resource consumption resulting from these patterns (Sustainable Consumption Roundtable, 2006). People mostly have no means of evaluating their resource consumption other than monthly electricity, gas and water bills, yet these mediums are not capable of providing any information related to environmental impacts of use.

There is a broad consensus that the resource consumption is considered as the consequence of solving everyday problems and meeting needs such as cleaning, cooking, lighting and comforting (Lockton et al, 2013a). As engaging with the products, individuals are mostly concerned about the experience rather than the resources consumed throughout the practice. The invisible nature of resources (e.g. water, electricity, etc.) in terms of sourcing and consumption considerably contributes to the lack of awareness related to their consumption in everyday practices and leads to intensive resource consumption.

2.4.2. Rebound Effect

Energy using products have become increasingly energy efficient through the technological improvements. Yet, these have raised the concerns about rebound effect that can be interpreted as using products more frequently and/or in an unintended way simply because they are more efficient in comparison to others. It is apparent that "the unintended use of product leads to unexpected and often negative environmental, economic or social consequences" (Lilley, et al, 2005, p.7). Despite the increase in energy effectiveness improvements in domestic appliances, between 1972 and 2002 use of domestic electricity by household appliances was doubled in UK (Energy Saving Trust, 2006). This reveals that the success of technological innovations to reduce environmental impacts noticeably depends on use behaviours particularly utilising the features employed and selecting the optimised settings provided by the products.

2.5. Sustainable Behaviour Change

Sustainability approaches in the design inquiry have been dominated by rethinking and reducing the implications of production and disposal of products, whereas the impacts emerged throughout the use phase have been considered less. However, realising the impacts of use patterns on the environment, the contribution of design to enable change in use behaviours has increasingly been explored in research studies. Design for Sustainable Behaviour (DfSB) is emerging as a new research area applying insights from multiple disciplines to reduce environmental and social impacts of product use through encouraging responsible and effective use behaviours

(Lockton, 2013; Elias et al., 2009; Wever, van Kuijk & Boks, 2008; Lilley, Lofthouse & Bhamra, 2005). This approach explores the potentials and implications of design strategies attempting to influence sustainable use patterns to be enacted throughout the use phase of a product (Lilley, 2007).

Research studies exploring the potentials of design for behaviour change show that there is not a single approach or methodology for leading users towards more sustainable patterns of use. Thus, design researchers within this particular research area have recently developed a range of taxonomies and categorisations including different perspectives and techniques (Lockton, 2013). Some of the approaches adopted so far will be explored in the following section to identify the significance of product design for encouraging responsible and effective use behaviours.

2.5.1. Approaches to Sustainable Behaviour

Technological intervention alone is not sufficient to influence behaviour, however a vital shift in use behaviour is essential for reducing impact of product use through design solutions. Considering this, Lilley et al. (2005, p.3) developed a model namely "interventions to change behaviour", and divided it into three categories, including *educational interventions*, *technological interventions* and *product-led interventions*. The latter also involves subcategories that are *scripts and behaviour steering, eco-feedback* and *intelligent products and systems*. The aim and scope of the strategies are presented in Figure 2.2 below.

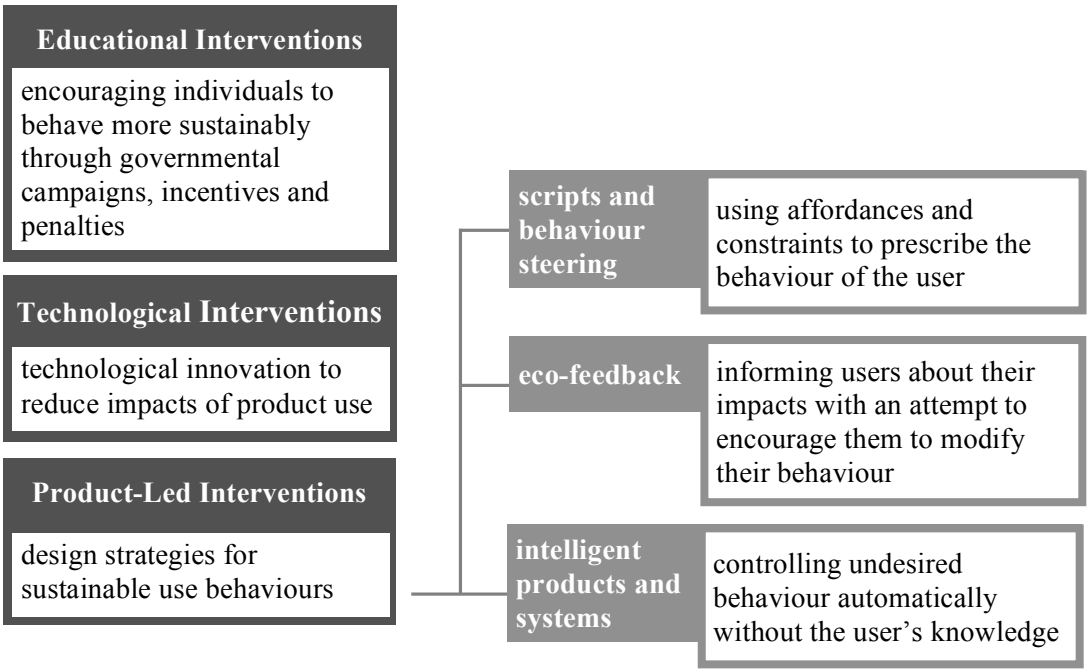

Figure 2.2: The categorisations of design strategies for sustainable behaviour suggested by Lilley, Lofthouse and Bhamra (reproduced from Lilley et al., 2005).

Wever et al. (2008) suggest a similar categorization in which the distinction between the design strategies requiring behaviour adaptation and functional matching is clearly defined. For some strategies (i.e. *eco-feedback* and *scripting*) the user is in control to adapt his/her behaviour while in others (i.e. *forced functionality*) the product has the power in influencing behaviour (Figure 2.3).

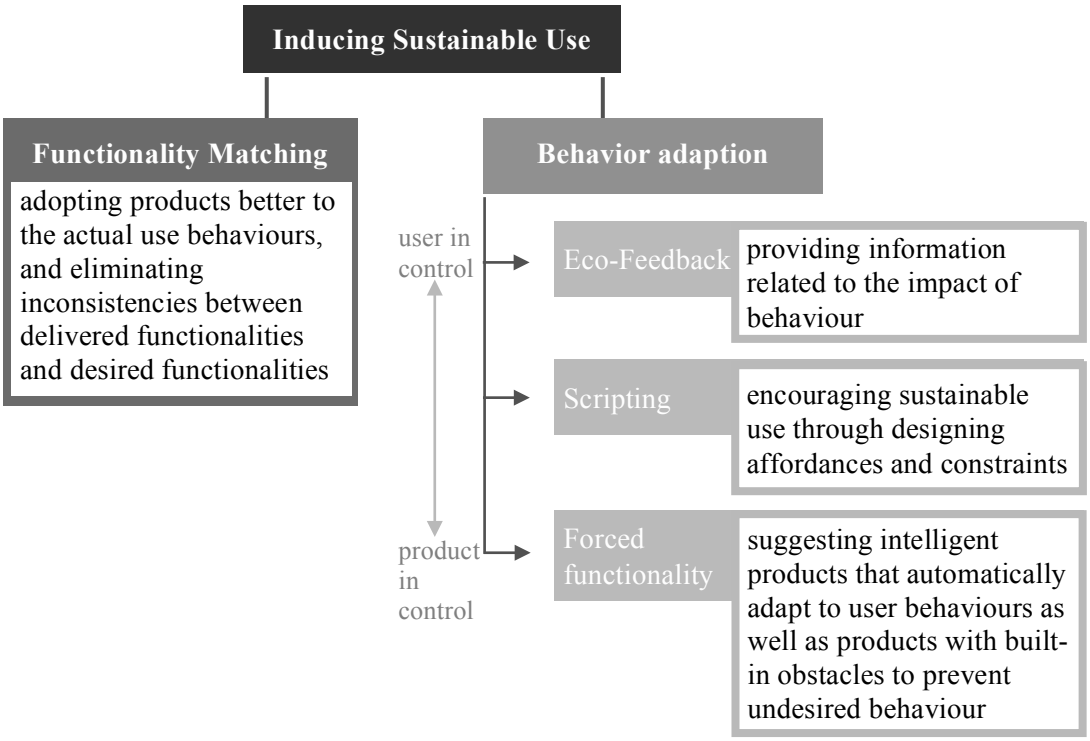

Figure 2.3: The categorisations of design strategies for sustainable behaviour suggested by Wever, Boks and Kuijk (adapted and reproduced from Wever et al., 2008).

Elias et al. (2007) propose a different strategy through which the behaviour is evaluated quantitatively. Focusing on the effective use of energy, the notion of "theoretical minimum" has been introduced to define the minimum amount of energy required to operate a product (Elias et al., 2007, p.1). Elias et al. (2009, p.115) evaluate the main causes of the deviations from the theoretical minimum of a product under two categories, namely "*intrinsic losses* determined by the technology and materials used to construct the product and the *user-related losses* which are caused by varying and inefficient use of that product by the user."

Considering the overall energy losses of a product, three strategies are proposed in relation to product design and user behaviour (Elias et al., 2007). The aim of the strategies is identified in Figure 2.4. The particular distinction suggests that product change and human change are the two possible routes for achieving behavioural change whether they are applied independently or in combination with each other.

Consumer Education	using existing products but with a greater consumer education through raising awareness of environmental and energy issues and improved instruction on efficient use of resources
Feedback	providing information to the user to increase awareness and reduce consumption accordingly
User-Centred Eco-Design	creating new products that use highly efficient technologies as well as considering the intended and unintended user behaviour in mind

Figure 2.4: Three strategies for more energy efficient use behaviour suggested by Elias, Dekoninck and Culley (adapted and reproduced from Elias et al., 2007).

The scope of the categories within these models is rather limited, since several intervention strategies have not been covered exactly. Thus Lilley et al. (2011) identified seven intervention strategies for behavioural change and range them on a spectrum with respect to who has the power in the decision making; the user or the product (Figure 2.5). Strategies (i.e. *eco-information, eco-choice, eco-feedback, eco-spur, eco-steer, eco-technical intervention* and *clever design*) identified within this model have extended previous approaches in detail. One advance of this approach in introducing the strategies is mapping them onto a spectrum to represent who has the power in decision-making and when an intervention is applied. This ranges from the user having control at the *eco-information* to the product with complete control at the *clever design*. Yet, the scope of the strategies and the borders between them are often not quite clear.

It can be interpreted from this categorisation that eco-technical intervention and clever design strategies are relatively short-term solutions to the unsustainable use patterns. Responsible practices are performed automatically and often without a conscious deliberation, so that as the interventions are removed, users may return to the existing use behaviours. However, user engagement at a more strategic level is required to sustain these use patterns.

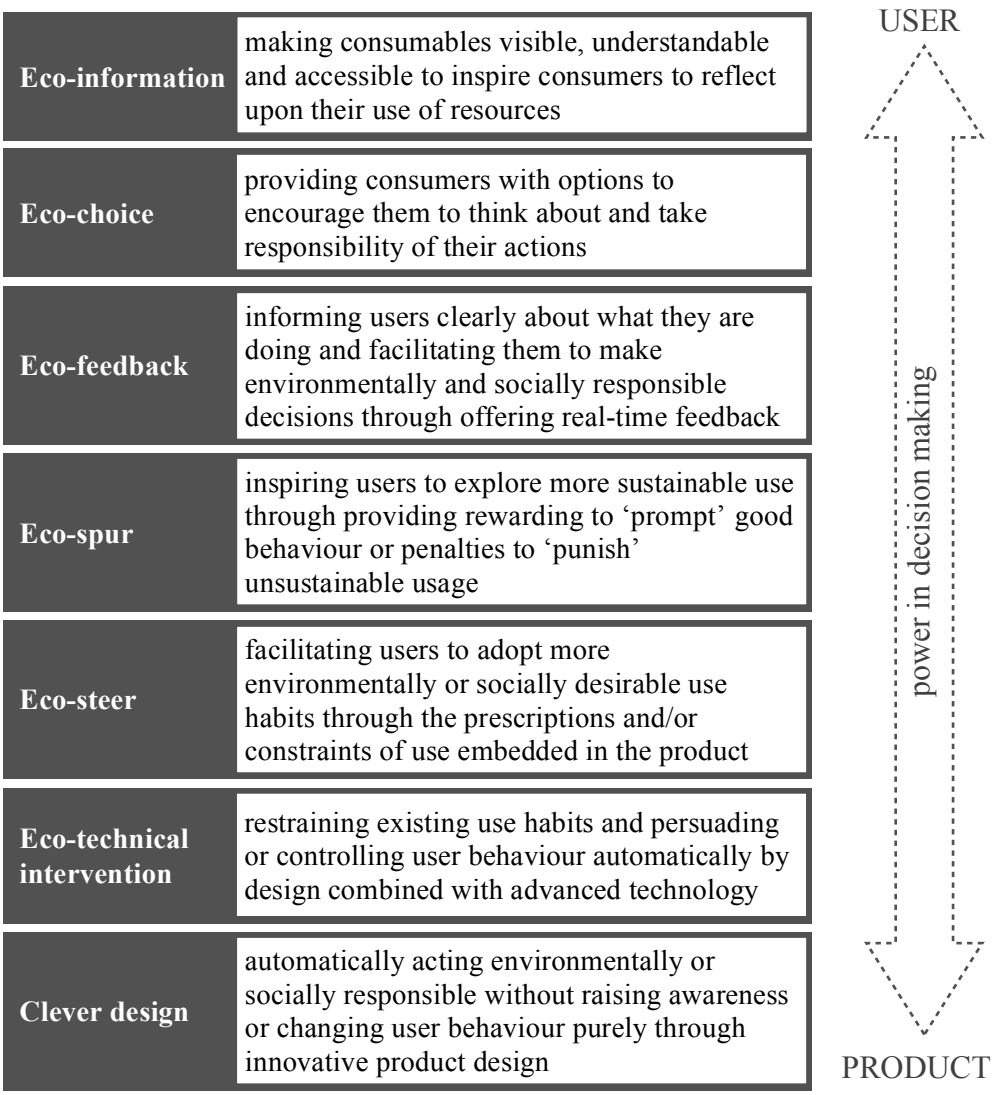

Figure 2.5: The categorisations of seven intervention strategies for sustainable behaviour suggested by Lilley, Bhamra and Tang (adapted and reproduced from Lilley et al., 2011).

Based on the previously mentioned perspectives (i.e. Lilley et al. 2008 and Wever et al. 2008), Lidman and Renström (2011) proposed a model for a sustainable consumption including five categories, namely *enlighten, spur, steer, force* and *match* (Figure 2.6). In the first four categories, the user is in control to change his/her behaviours and the responsible use patterns are encouraged through motivating or directing the user. The fifth category, *match*, differs from the others, since product has a complete control and requires little or no adaptation by the user (Lidman & Renström, 2011). The scope of the strategies is well-defined and considerably simple

to distinguish compared to the strategies in the previous model (Lilley et. al. 2011).

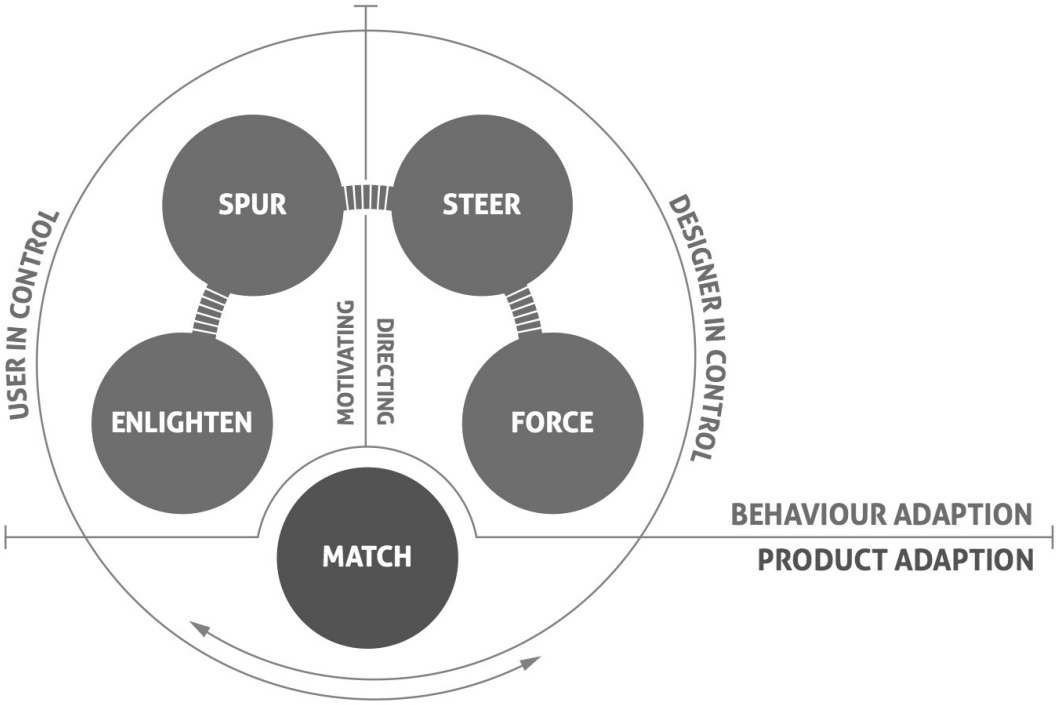

Figure 2.6: The categorisations of design strategies for sustainable behaviour suggested by Lidman and Renström, 2011 (Retrieved from http://publications.lib.chalmers.se/records/fulltext/142461.pdf on June 20, 2014).

Lockton, Harrison and Stanton (2013b) developed a tool named *Design with Intent Toolkit* for guiding designers to address sustainable behaviour problems and implement design solutions to influence those behaviours through product design. The toolkit consists of cards involving insights and examples from different disciplines for influencing behaviour (Figure 2.7). This tool aims to provide a guide for designers to influence behaviour as well as serve as a teaching instrument for workshop sessions and design projects. The categorisation of the strategies is quite different from the previously mentioned approaches, yet the toolkit is a good example of compiling and presenting design strategies in a way to ease its implementation within the design practice.

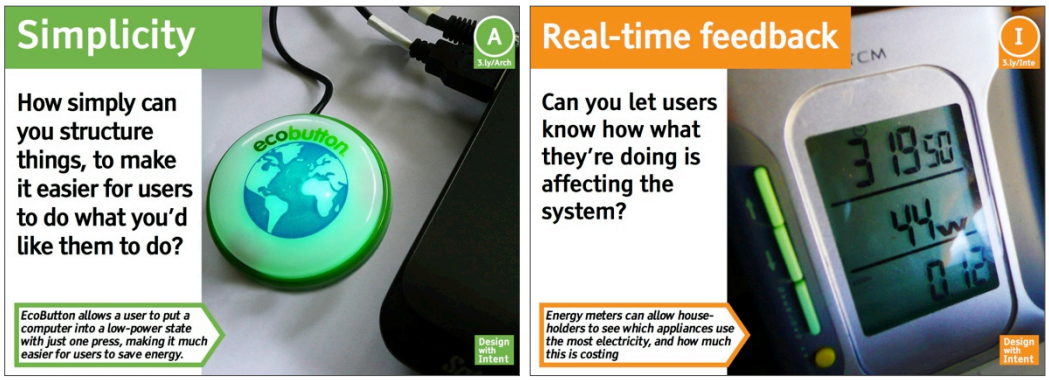

Figure 2.7: Selection of cards from *Design with Intent Toolkit* by Lockton, Harrison and Stanton, 2013 (Retrieved from http://www.danlockton.com/dwi/Main_Page on March 3, 2014).

In this thesis, understanding use behaviours along with the use of resources (i.e. water and electricity) in small household appliances has been the primary concern to explore problems relevant to resource effectiveness and inform design directions accordingly. Although developing design ideas to prompt sustainable use behaviours has not been the concern of this research, the overview of the DfSB approaches has provided a basis to evaluate use behaviours throughout the study and contributed to the development of a new strategy (i.e. eco-engage) that will be explained further.

Considering the existing approaches as well as the aim and scope of this study, three strategies (i.e. eco-feedback, eco-steer and eco-engage) have been highlighted and presented for effective use of resources in small household appliances (Figure 2.8 below). Providing the use of resources is closely related to increasing users' awareness and motivating energy saving use patterns. *Eco-feedback*, in this regard, aims to inform the user related to the consequences of his/her use behaviour through sensorial manifestations (e.g. visual, auditory, tactile, etc.) of resource consumption. *Eco-steer*, on the other hand, intends to guide the user to consume resources responsibly through affordances and constraints embedded in the product. In this category, design interventions can be implemented through simply enabling the energy saving behaviours for an easier adaptation by the user as well as constraining the behaviours leading to intensive resource consumption automatically without users' knowledge. Yet, providing information and/or built-in affordances and constraints for effective use of resources do not ensure that the user will engage in

these design interventions. However, detailed and comprehensive understanding of the user, his/her needs and preferences in a particular context is required for an engaging use. Therefore, apart from these categories, realising the considerable gap in the related literature, "*eco-engage*" has been suggested in this study to define a new strategy for effective use of resources. It aims to facilitate engaging use through providing affordable and accessible design interventions that can be tailored to the user's diverse needs and preferences for resource effectiveness.

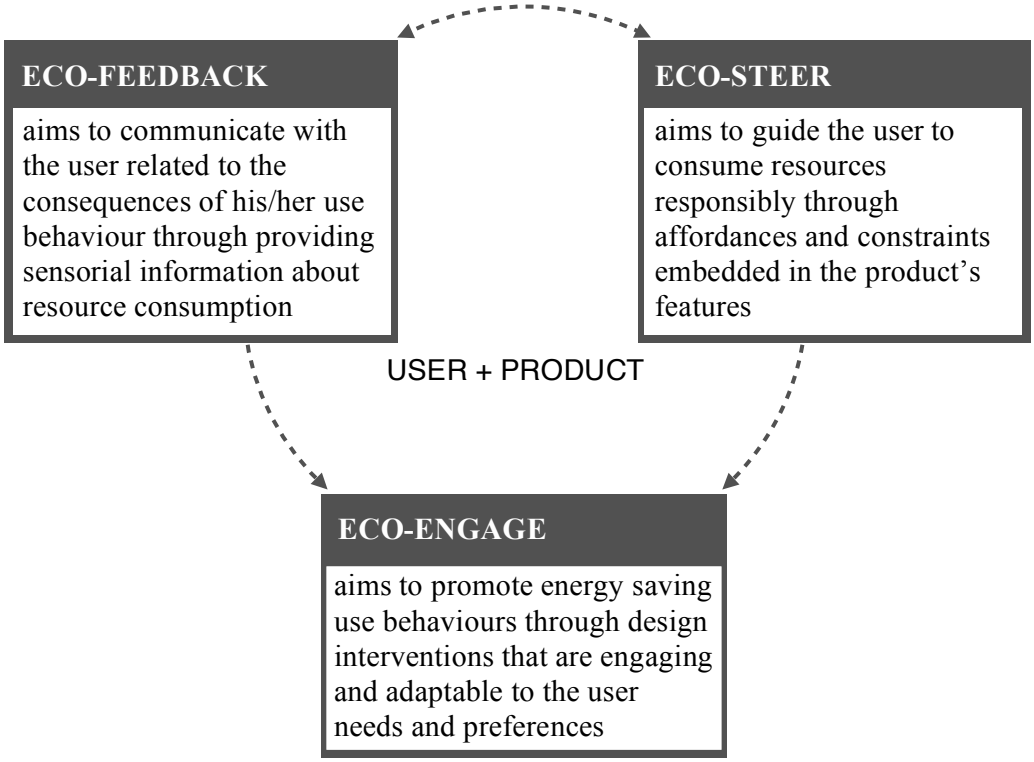

Figure 2.8: Three strategies for effective use of resources in small household appliances.

The design strategies and approaches explained so far have been implemented in a wide range of products to influence and/or change use behaviours at a more strategic level. In the following section these will be explained with a particular focus on resource consumption through a selection of examples.

2.5.2. Implications of DfSB Approaches in Product Design

The implications of DfSB approaches for product design will be categorised and explored further under three subtitles, namely eco-feedback, eco-steering, and eco-engage.

2.5.2.1. Eco Feedback

Design interventions including eco-feedback visualise the results of consumption patterns through sensorial means (e.g. auditory, visual, tactile, etc.). However, it is not just the presence of the feedback that can influence behaviour but how that feedback is provided. The feedback may vary from simply informing the user about the impacts of consumption patterns to promoting a different behaviour through providing comparison to the previous practices and/or offering incentives and rewarding for achieving a goal.

There are several examples of integrating eco-feedback design strategies into product concepts with an emphasis on domestic energy consumption. For instance, considering the invisible nature of energy and its implications for consumption, the *Power Aware Cord* (Figure 2.9) has been designed to visualise the energy rather than hiding it (Gustafsson & Gyllenswärd, 2005). In this redesign of an electric cable, the use of electricity of appliances connected to the cord is represented through glowing pulses, flow and intensity of light. Feedback received from the cord can be used to explore energy flow within the domestic environment, and consequently notice unnecessary resource consumption that might result in considerable reduction. Although in-depth user studies to verify its effects on domestic resource consumption have not been conducted yet, an initial user study carried out to explore user's reactions towards such an intervention reveal that the *Power Aware Cord* is an intuitive medium for a better understanding of the energy use (Gustafsson & Gyllenswärd, 2005).

Another example is *Wattson* which is a wireless energy monitor that aims to reduce resource consumption by making consumers more aware of the energy used by household devices (Figure 2.10). In this design solution, information from the household electricity meter or fuse box is transferred to the *Wattson*, which instantly

displays consumption in a simple graphic display in kilowatts. The feedback is also supported through graduated light; blue for low energy use and red for high. User studies conducted so far to explore its utilization and long-term implications have been primarily qualitative in nature. For instance, a research study that was carried out with six families in the UK for an eight-week period revealed that the clarity of the energy consumption information would be valued by all of the households, which turn into energy saving behaviors. However, quantitative data to support its effect on domestic resource consumption is not currently available (Kelsey & González, 2009).

Figure 2.9: *Power Aware Cord* by Gustafsson and Gyllenswärd, 2005 (Retrieved from http://homepages.lboro.ac.uk/~cddl/power_aware_cord.htm).

Figure 2.10: *Wattson*, energy monitor by Greta Corke, Richard Woods, and Jon Sawdon Smith, 2006 (Retrieved from Kelsey & González, 2009).

Energy Aware Clock is designed with similar considerations (Figure 2.11 below). The clock uses a relatively abstract time metaphor to visualise domestic electricity consumption. It is wirelessly connected to an energy meter, and as an electrical appliance is switched on, a longer dial is seen on the display. As time progresses, the dial leaves a trace behind on the display which shows the energy consumption in time. The main goal ultimately is to shrink the pattern each day and save energy. A user study was carried out to explore the integration of the prototype into real domestic contexts for three months with nine households in Stockholm. The results of the qualitative study indicated that the product played a significant role in drawing households' attention to their electricity use and encouraged them to conserve energy (Broms et al., 2010).

Figure 2.11: *Energy Aware Clock* by Loove Broms, Karin Ehrnberger, Sara Ilstedt Hjelm, Erika Lundell and Jin Moen, 2008 (Broms et al., 2010).

The above-mentioned product cases have employed different strategies to visualise domestic energy consumption, which remains unnoticed otherwise. *Power Aware Cord* successfully visualises the energy flow, but lacks the quantitative representation of the consumption whereas *Wattson* and *Energy Aware Clock* present the overall consumption thoroughly. Yet, none of the products enable users to make comparison of their energy consumption per product in the domestic environment.

2.5.2.2. Eco Steer

As implementing the eco-steer in product design, the undesired use behaviour can be prevented through making it physically and/or cognitively challenging or impossible, whereas the desired behaviour can be encouraged through making it effortless so that it becomes the obvious way of using the product. However, the strategy can also result in sustainable consumption patterns without a conscious change in use behaviour.

One such example of this design strategy is the *Tefal Quick Cup*, which is a redesign of a contemporary kettle (Figure 2.12). This kettle has been separated into two parts, a water reservoir and a boiling section that each time affords to boil water that equals to a single cup. Overfilling the kettle can result in intensive water and energy consumption (Elias et al., 2009). Through this design intervention, the user can evaluate his/her needs and make a conscious choice to boil more water than required. *Integrated toilet and washbasin* is another example that has been developed to reduce water consumption in the bathroom through reutilising the water used for hand-washing to flush the toilet (Figure 2.13).

Figure 2.12: *Tefal Quick Cup* kettle (Retrieved from http://tevami.com/2009/06/21/tefal-quick-cup-clean-water-in-an-instant/).

Figure 2.13: *Integrated toilet and washbasin*, by Caroma, 2008 (Retrieved from http://homepages.lboro.ac.uk/~cddl/integrated_toilet_and_sink.htm).

The design solutions mentioned above have adopted different strategies in terms of the user's intervention within the use phase. In *Tefal Quick Cup*, the product limits overfilling the kettle through automatically adjusting the water level, but it also enables user to think about his/her needs and consumption patterns. However, in the latter example, the user does not have any power in decision-making for water consumption, and acts automatically environmentally responsible without a conscious deliberation. When the design solution is removed, the user may return to his/her prior use behaviour.

2.5.2.3. Eco-Engage

The implications of eco-feedback and eco-steer design strategies are capable of informing and guiding users towards environmentally responsible and effective use behaviours. However, the design solutions need to enable engaging use and adapt to the existing user needs and preferences as well through offering simple and affordable solutions in order to be accessed and accepted by the users.

The Tyranny of the Plug kitchen series is a conceptual design project that questions the users' reliance on resources such as electricity, gas, etc. to power household devices (Figure 2.14). The kitchen appliances in this concept (i.e. a blender, a mixer

and a lemon squeezer) are operated via human power. The design solution encourages the users to engage with the resource use in an unusual way, and aims to inspire them to consider the generation of power, and reflect this upon their use of resources.

Figure 2.14: *Tyranny of the Plug* by Dick van Hoff, 2003 (Retrieved from http://homepages.lboro.ac.uk/~cddl/tyranny_of_the_plug.htm).

Vampire plug is a redesign of a conventional plug that involves a mechanical timer for adjusting the duration of charging, and in turn reduces excessive energy consumption resulting from leaving products plugged in (Figure 2.15). The user adjusts the timer based on his/her previous experiences, and pulls its string to start the timer. The design concept enables users to evaluate their use behaviours along with their needs and transfer this knowledge into the product.

Design interventions introduced within the scope of *eco-engage* strategy require user involvement to utilise the products with various degrees. *Tyranny of the plug* series are operated through the user without the need of electricity whereas the latter simply needs the user knowledge derived from past experiences to consume resources effectively. Each of the design interventions offers affordable alternatives to the existing products through simple solutions and also facilitates environmentally responsible use behaviours. However, their engaging capacity for effective use of

resources should also be evaluated from the users' viewpoints and supported by user research.

Figure 2.15: *Vampire plug* by Oliver Poyntz, 2009 (Retrieved from http://homepages.lboro.ac.uk/~cddl/vampire_plug.htm).

2.6. User Centred Research Studies

Effective use of resources can be managed through understanding what leads to intensive resource consumption that is related to the product's intrinsic properties, use patterns or a combination of both. Within this context, user-centred research methods are required for a comprehensive understanding of individuals' needs, values, experiences and preferences along with the use contexts that are linked to the intensive resource consumption.

Within the area of DfSB, a few research studies have been carried out for gaining insights into the domestic resource consumption and use behaviours resulting in its use. User-centred research studies that have inspired this research will be explained in the following sections further.

2.6.1. The Case of Refrigerators and Freezers

Refrigerators and freezers consume energy twenty-four hours a day and account for 20% of the overall domestic energy consumption (Energy Saving Trust, 2012).

Considering this, with the aim of exploring design opportunities to reduce environmental problems of use behaviours and activities around the refrigerator and freezer relevant to energy and food consumption, Tang and Bhamra (2008) conducted a comprehensive study which was also examined further in Tang's (2010) doctoral thesis. Designing for sustainable use of products requires a comprehensive understanding of actual use behaviours (Tang, 2010; Tang & Bhamra, 2008). In this regard, throughout their study user-centred qualitative research methods were employed including questionnaires, user observations and interviews to capture actual use behaviours, habits and attitudes of users while interacting with the products (i.e. refrigerator and freezers) as well as to explore user-product relationships in different contexts. The use activities around the products were categorised into three related groups, namely condition and environment of product use, food shopping unpacking, and food preparation. The findings of the studies revealed a series of use patterns that were closely related to the intensive energy consumption (e.g. making room for the new items inside the refrigerator and/or freezer, looking for the desired food, etc.). Considering these findings, several product-led solutions were suggested for encouraging responsible use behaviours in refrigerators and freezers (e.g. designing to better display the content within the refrigerator, software to keep food shopping record to reduce the opening time for seeking foods, etc.). Consequently, the study revealed the importance of comprehending the actual use behaviours through adopting user-centred research methods in real-life situations for the development of products to reduce environmental impacts (Tang & Bhamra 2011).

2.6.2. The Case of Heating and Lighting Appliances

Another research study conducted is a part of the SusLabNWE projects that employs user-centred research methods for gaining insights into the intensive energy consumption patterns in domestic environments (Lockton, et al., 2013a). The on-going project aims to understand users' routines, motivations and their interaction with heating and lightning appliances to identify opportunities for design interventions that can reduce everyday energy use in domestic contexts (Lockton, et al., 2013a). In this regard, in the first phase of the research, a series of home visits

and interviews with a diverse range of householders were carried out. Later the participants were provided with a logbook and a disposable camera for exploring everyday routines and householders' understanding of energy in detail. This stage has been complemented with second home visits and interviews, enabling further exploration and elaboration of use behaviours. Even though it is at the early stages of a larger project, the findings of the study have clarified that the user-centred research methods employed so far have provided deeper insights into the people's everyday strategies about energy use which are difficult to explore otherwise (Lockton, et al., 2013a). These strategies involve self-imposed rules and household policies such as replacing halogen spotlights to reduce electricity use, removing radiators when they provide heat more than needed, and controlling each radiator in the domestic settings to adjust temperature in line with the user preferences. In the following phases of that research, acquired data will be used to structure the prototypes of products and services through a participatory design approach with the aim of influencing people to reduce their energy use as meeting their needs.

This chapter has reviewed the literature that has been found consistent with the aim and scope of this study to provide an understanding of the background and context of the research problem. In this thesis, use patterns throughout the use phase of small household appliances will be explored with a focus on resource consumption, particularly in electric tea makers and contact grills. In the next chapter, the research design along with the data collection and analysis methods employed will be explained in detail.

CHAPTER 3

METHODOLOGY

This chapter explains the methodological approach adopted throughout this research and presents a comprehensive overview of the research process. Firstly, research stages with a particular emphasis on the reasons of adopting a qualitative research methodology will be clarified. Afterwards, the research process including data collection methods, the development of interview and focus group questions, access to participants, data analysis methods (i.e. content analysis and thematic coding and analysis) adopted within the research will be described under the titles of *preliminary research* and *primary research stages.*

3.1. Research Approach

A wide range of considerations influences in determining the methodological approach that are incorporated into the research study such as the aim and goals of the research, the nature of knowledge, the means of gathering data, the characteristics of the participants, and the intended audience of the research (Ritchie & Lewis, 2003). Qualitative research aims to provide a detailed and interpreted understanding of the social and material world of its participants through exploring their experiences, perspectives, values, beliefs and histories (Ritchie & Lewis, 2003). Quantitative research, on the other hand, seeks generalized findings through precise measurements and analysis (Maykut & Morehouse, 2005). Qualitative research is exploratory and investigative in nature, and the findings from a sample cannot be used to make generalizations about the population of interest, since it is sensitive to the context (Maykut & Morehouse, 2005).

This study seeks an in-depth understanding of people's experiences and behaviours in the use phase of small household appliances with a particular focus on resource

consumption, which is closely in line with the nature of qualitative research. Considering the goal of this research, user observations, semi-structured interviews and focus group sessions, all of which will be explained in the following sections, became productive means of gaining a detailed understanding of individuals' experiences and use behaviours regarding effective use of resources.

3.2. Research Stages

This research consists of mainly three parts including literature review, preliminary study and primary research. Preliminary study was conducted with the aim of evaluating the research scenario and interview questions for the further stages of the research. Regarding the aim of the research, the primary research stages adopt various data gathering methods, namely user observations, interviews and generative focus group sessions. Each stage of the primary research was planned based on the findings of and conclusions from the previous ones. The research stages, purpose of the studies and their relations to each other are presented in Figure 3.1.

3.3. Preliminary Study

Prior to the primary research stages, a preliminary study was conducted in order to check the clarity of the interview questions and the flow of the interview schedule as well as to determine the usefulness of the questions to elicit the relevant data for the purpose of the study.

3.3.1. Population and Sampling

Selecting population includes identifying individuals that are capable of providing the most relevant and comprehensive information through considering their relation with the research questions (Ritchie & Lewis, 2003). Preliminary study was conducted with one electric tea maker user with the aim of evaluating the interview questions. Convenience (i.e. availability) sampling, in which the eligible participants are selected regarding their relative ease of access (Morgan, 2008), has been adopted to recruit the participant. The study was conducted in the participant's house to be able to capture use behaviours in the real-life context.

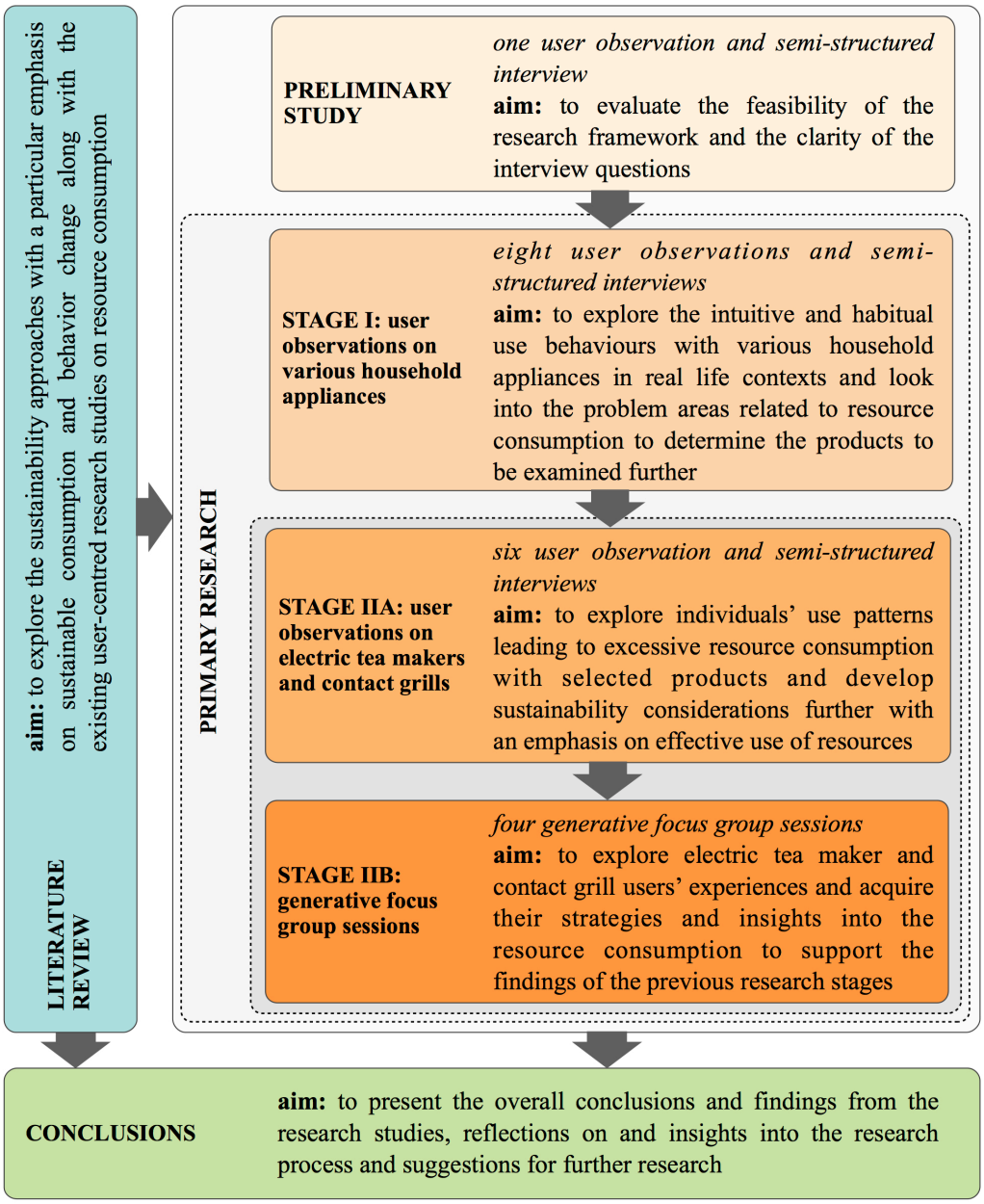

Figure 3.1: Research stages.

3.3.2. Data Collection: User Observations and Interviews

What individuals say about what they do is often contradicted with their actual behaviours. In research studies that explore the practices and behaviours of people, mostly observational methods are preferred to look into their actions that are recorded, later described, analysed and interpreted (Robson, 2002). Participant observation enables the researcher to comprehend the patterns of behaviour, experience the unexpected as well as the expected, and explore the participants'

activities corresponding to their responses in the research settings (Glesne, 2011). User observations used in this research are similar to participant observations in nature aiming to explore the individuals' experiences in their real-life contexts through capturing the behaviours around a product or an activity.

In the preliminary study one user observation was conducted with an electric tea maker user to explore the use phases and participant's habitual use behaviours leading to excessive resource consumption. The observation was supported by a semi-structured interview to comprehend the experiences thoroughly.

Individual interviews are widely used in qualitative research studies due to their ability to provide a direct focus on the individual, and to explore the specific personal perspectives thoroughly within the context (Ritchie & Lewis, 2003), which made them valuable for this phase of the research to complement the observations. The interview questions were prepared and categorised in four parts based on their content and intended aim, namely warm-up questions, observations, experience/behaviour questions and opinions/insights questions (Table 3.1). In the first part, general information related to the use environment and the features of the product were inquired. Later, the respondent was asked to perform a task with the product, and use patterns were observed without intervening in the process, to explore the participant's intuitive and habitual use behaviours as much as possible. Thirdly, the participant's use experience (e.g. duration of use, complaints, appreciated features, accidents, etc.) was questioned with the aim of exploring potential problem areas related to resource consumption. Finally, the insights regarding effective use of resources were requested. Prior to the interview, an informed consent (Appendix A) was read to the interviewee with the aim of providing the participant with information about how and where the data would be used, how long the interview would take, what would be required from the respondent and how the anonymity of the interviewee would be achieved, and the approval of the participant was requested. The interview session took approximately 20-25 minutes whereas the observation phase, which proceeded from turning on the product to the cleaning phase, took approximately 70 minutes. The transcription of the data along with the analysis procedure will be explained further (Section 3.4.3 and Section 3.4.4).

Table 3.1: Preliminary research interview questions and their intended aim.

Interview Questions and Intended Aim	
Warm-up questions	**Q1.** Could you describe the use environment for the product (e.g. the characteristics of the use environment, spatial arrangement of the product in relation to other products, etc.)? Also, if applicable, tell me more about the atypical use environments and occasions such as living room or balcony, or friends gathering in the garden.
	aim: to explore the relationship between the use environment and product performance, and its impact on the resource consumption (e.g. dust, heat, etc.).
	Q2. What are the characteristics and features of the product (e.g. physical characteristics, controls, displays, technical features, additional functions and accessories, etc.)?
	aim: to acknowledge the physical and technical features of the product, exploring product parts and their function.
	Q3. What are the selection criteria for choosing that particular product (e.g. energy efficiency, features, etc.)?
	aim: to explore the impact of energy efficiency on users' consumption or purchasing behaviour.
Observations	Q4. Could you perform a task with your product?
	aim: to observe the use experience and the use phases of the product (e.g. preparation, boiling, re-boiling, cleaning, etc.) and relating them with resource consumption; to observe habitual and routine use behaviours leading to excessive resource consumption; to observe how design details (e.g. displays, lights, controls, materials, etc.) provide information to the user related to resource consumption; and to observe the nature (e.g. visual, auditory, tactile, etc.), frequency and duration of the feedback.
Experience/behaviour questions	**Q5.** What are your significant experiences with your product (e.g. frequency, duration and occasions of use, complaints or appreciated features, accidents and safety issues, etc.)?
	aim: to explore the expertise of the user, frequency and duration of product use and relating this data with resource consumption; and to inquire into the potential problem areas related to resource consumption.
	Q6. What are the other values and functions ascribed to the product (e.g. alternative usage scenarios, etc.)?
	aim: to explore the product's alternative usage scenarios and their relation with resource consumption.
Insights	**Q7.** What are the main problem areas related to the resource consumption in the use phase of the product? What are your suggestions regarding effective use of resources?
	aim: to explore resource consumption related problem areas in the use phase of the product; and to acquire participants insights into the problem areas and suggestions of the potential design directions for the effective use of resources.

3.4. Primary Research I: User Observations on Various Household Appliances

In the primary stage of the research, eight user observations were conducted to explore use phases and use behaviours leading to intensive resource consumption for water and electricity (Figure 3.2). The products (i.e. air humidifier, contact grills, Turkish coffee maker, tea maker, bread maker, steam iron, mini oven and electric frying pan) were selected based on their frequency and duration of use in domestic everyday life along with their impact on domestic resource consumption. The product-user interactions were observed in their real-life settings through home visits. Similar to the preliminary study, the observations were supported by semi-structured interviews to comprehend the experiences thoroughly.

Figure 3.2: The images from the *primary research I: user observations on various household appliances.*

3.4.1. Population and Sampling

Qualitative research studies often employ non-probability sampling technique for reaching a small number of intense data sources (Morgan, 2008). In this phase of the research, snowball sampling, which is a type of non-probability sampling, has been used as a recruitment method. In this method, the participants who have already been

interviewed were asked to use their social network to identify people who would fit the selection criteria, and could participate in the research (Mason, 2002). Participant's availability to take part in the study was also essential, since the observations would be conducted in their homes and the duration of the observation would be slightly long. Therefore, convenience (i.e. availability) sampling has also been adopted. The individuals who frequently use one of the products of inquiry were prioritised for the reliability of the research. The participants who were involved in this phase of the research were aged between 21 and 58, and used the product of inquiry for more than a year. Each observation was conducted in the respondent's homes for acquiring a wide range of data in their real-life setting. The details related to the sampling are presented in Table 3.2.

Table 3.2: *Primary research I* participant information.

participants	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
age	22	48	50	58	31	48	44	37
gender	Female	Female	Female	Female	Female	Female	Female	Female
occupation	student	teacher	retired accountant	manager	financier	teacher	secretary	housewife
product of inquiry	contact grill	Turkish coffee maker	mini oven	electric tea maker	bread maker	electric frying pan	steam generator iron	air humidifier

3.4.2. Data Collection: User Observations and Interviews

In research design, it is essential to consider the issues of reciprocity, which is giving something in return for the time and contribution provided by the research participant (Glesne, 2011). Before starting the interview, in order to show gratitude to the interviewees for allocating their time and sharing their experiences, small gifts (i.e. cookies and a box of herbal tea) were presented by the researcher. These gifts were also believed to help interviewees to welcome the researcher in their homes.

Following this, the participants were informed regarding the scope of the study, however the expression ''resource consumption'' was avoided in order not to alter the flow of the interviews. If that specific term had been used, throughout the interviews they might have responded questions or reshaped their use behaviour

considering the resource consumption, and exploring their habitual behaviours and receiving reliable responses might have been quite difficult, and this would have directly affected the validity of the data gathered. Later, an informed consent was read to the participants for their approval (Appendix A). After receiving the participants' verbal approval, they were offered to sign the consent form at the end of the interview in order not to make them feel stressed.

In this phase of the research, the interview questions, which were evaluated through the preliminary study, were utilised with an exception of the final question (see Table 3.1). It was revised and rephrased as follows:

> **Q7.** Considering the use stages, what would be your suggestions for the improvement of the product particularly for the effective use of resources?

Audio and video recording, photographs and note-taking were used for documenting the interviews with the aim of capturing participants' interaction with the products and feedbacks (e.g. auditory, visual, tactile, olfactory, etc.) received throughout the use phase. The duration of interview sessions varied from 40 to 190 minutes depending on the product of inquiry. Baking bread for example, took roughly three hours and each use phase was observed in detail for a comprehensive understanding of the use experience. In this case, the researcher paused the voice recorder and the video camera occasionally throughout the observation, and played the role of the guest along with the researcher in order not to overwhelm the participant. However, the respondent continued his/her comments related to the research topic and these quotes were documented through note-taking.

3.4.3. Transcribing the Data

Transcription is a written representation of what is being recorded, and it is inevitably an interpretation of the interview to some extent (Kvale, 2007). Verbatim transcription was essential for the purpose of this research to comprehend respondents' experiences with their products thoroughly. Therefore, each statement was transcribed word by word on an Excel worksheet, however, emotional expressions and pauses were often excluded, since they were not crucial for the

study. The researcher's observations were also transcribed with the aid of the personal field notes and video recordings of use phases.

3.4.4. Data Analysis Methods: Content Analysis and Thematic Coding

Once the data have been collected and transcribed, the following phase for a qualitative researcher is to analyse and interpret the raw data. With the aim of preserving the richness of the qualitative data as organising and making inferences from it, inductive content analysis and thematic coding and analysis were preferred throughout this study. Content analysis is a widely used data analysis strategy in qualitative research studies in which various kinds of data; for instance textual data from interviews, observations, narratives and visual data from photographs, drawings and videos, are organised into codes, themes and conceptual categories (Julien, 2008). Those categories may be generated from the existing theories in deductive approach, whereas in inductive approach, they simply emerge from the raw data within the research (Julien, 2008). In qualitative studies the latter approach (inductive) is often adopted. Thematic coding is a data analysis method that focuses on exploring the significant themes within the data through categorising, summarising and reconstructing the qualitative data (Ayres, 2008).

The analysis of the data acquired from the study was carried out in several steps (Figure 3.3). The interview schedule was deliberately organised as a conversation rather than an exchange of questions and responses, thus several irrelevant data have appeared within the verbatim transcriptions. In this respect, relevant phrases and observations were selected from the raw data and organised based on the interview flow and phases of use experience. Later, interpretations were made on the interview responses and observations for a detailed understanding of the use experience. The analysis continued with the development of themes derived from the interpretations that are related to the intensive or excessive resource consumption. An example of how the data was interpreted and the considerations emerged is presented in Table 3.3.

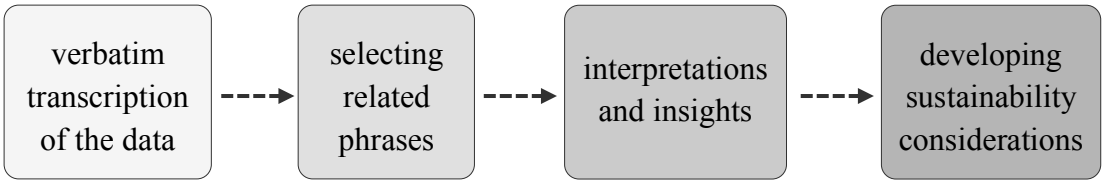

Figure 3.3: Data analysis strategy for content analysis.

Table 3.3: An example of the interpretation of the data and the development of the themes from the bread maker case.

	Observations	Interpretations and Insights	Themes
turning off	While removing the breads, it was observed that one of the blades was not placed properly. Thus the dough could not be kneaded and one of the breads was baked poorly.	Since the processes are automated, the participant does not check the bread throughout the whole process. Product worked for three hours with a fifty percent performance leading to excessive resource consumption.	visibility of the process/modes, automation of the process

In this observation, it was revealed that a strong trust in the product might lead to excessive resource consumption. The problem area was assessed as *the visibility of the process/modes* due to the product's insufficient feedback regarding the proper assembly or adjustment of the components. This case is also related to *the automation of the process.*

Determining and developing considerations was an iterative process, throughout the analysis phase the themes were revisited and revised several times as the new data emerged.

3.5. Primary Research IIA: User Observations on Electric Tea Makers and Contact Grills

In this stage of the research, based on the problem areas identified through the analysis phase, two products (i.e. tea makers and compact grills) were selected to be examined further, since those appeared to be the most problematic ones in terms of resource consumption during use phase. For each product, three semi-structured interviews along with user observations were conducted with the aim of inquiring

detailed information related to use patterns leading to excessive resource consumption (Figure 3.4).

Figure 3.4: The images from *primary research IIA: user observations on electric tea makers and contact grills.*

3.5.1 Population and Sampling

The sampling of the participants was done with snowball technique. Existing participants who took part in the previous stages of the research were asked whether they would know experienced tea maker and compact grill users. The interviewees participated in this study were aged between 25 and 55, and were regular users of the products of inquiry (Table 3.4).

Table 3.4: *Primary research II* participant information.

participants	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
age	25	32	48	29	55	28
gender	Female	Female	Female	Female	Female	Female
occupation	research assistant	financial advisor	secretary	product designer	manager	biologist
product of inquiry	electric tea maker			contact grill		

Recruiting participants was not a challenging process, since they were mostly supportive; however, arranging the date for this phase was quite compelling. The interview schedule and research outline were designed to conduct the user observations and interviews wherever the participants would use their products (e.g. home, office, etc.). Even so, feeling that entering their private homes might be stressful for them, they were asked to arrange the meetings based on their availability, which resulted in rescheduling the interviews several times.

3.5.2. Data Collection: User Observations and Semi-Structured Interviews

Semi-structured interviews have predetermined key questions; however, they enable the researcher to do some probing for further information on the topic of interest (Ritchie & Lewis, 2003; Mason, 2002), which makes the interviews valuable for this phase of the research.

The majority of the interview questions utilised in the previous stages were quite satisfactory. However, a few questions were revised and emerging questions were included in the guideline. For instance, the wording of the final question was found confusing. The expression ‘resource consumption’ was also misunderstood as raw material consumption in the production phase of the products as well as the water and electricity consumption. Therefore, the final question was revised and separated in two parts as follows:

Q7. What are the methods/strategies you have developed to reduce resource consumption (i.e. water and electricity) throughout the use phase of your product (e.g. boiling, brewing, keeping warm, cleaning, etc.)?

Q8. Do you have any suggestions for improving the product of inquiry in terms of effective use of resources?

The interview guideline was categorised in three parts including warm-up questions, experience/behaviour questions and opinions/insights questions (Appendix B). It is quite complex to explore individuals' actual use behaviours through interviews, since it is possible that they may claim to do something they actually do not perform. To overcome this, in the second phase, the interviewees were requested to describe their experience and use behaviours through performing a task with their products (e.g. brewing tea, toasting a bread, etc.).

In the previous stages of the research (i.e. *primary research I*), the researcher adopted the role of the observer without intervening into the process, as the participants were engaging with their products. However, through analysing the video recordings it was recognized that several use behaviours might have been explored further through probing to understand the motivations behind such patterns of use. Therefore, in this second stage of the primary research, experience/behaviour related questions were explored in detail with the aid of a series of follow-up questions and probes. Depending on the flow of the interviews, emerging questions were inquired; for instance, how they adjusted the water level for brewing tea or how they determined the temperature for grilling to comprehend the motives and considerations behind these behaviours, which might lead to intensive resource consumption. This method enabled to explore the intuitive and habitual use behaviours performed with little deliberation and limited awareness.

In the first stage of the primary research, it was also observed that the participants had difficulties while relating use behaviours to their possible environmental and social consequences. To overcome this issue, prior to the opinions/insights questions the participants were provided with a focusing paper (Appendix C), in which several facts related to domestic resource consumption arising from unsustainable use behaviours were presented. The aim of the focusing paper was to present a reliable

information to the participants relevant to the research area, and draw their attention into the research. Later, considering these environmental facts, the interviewees' insights related to resource consumption (i.e. water and electricity) within the use phase of their products were inquired. The interview guideline prepared in Turkish and English can be found in Appendix B.

The duration of the sessions differed based on the product observed and the task performed with it, for instance brewing tea took quite longer compared to toasting a bread. The length of the observations along with the interviews ranged from 80 to 110 minutes for electric tea maker cases and 40 to 65 minutes for contact grill cases.

Audio recording, video recording, photographs and note-taking were used for documenting interviews. Nonverbal aspects of the interviews, for instance individual's interactions with the product and feedbacks (e.g. auditory, visual, tactile, olfactory, etc.) were quite valuable for the research, therefore both audio and voice recording were used for documenting data. However, two electric tea maker and one contact grill user did not agree to video recording. Since, it is difficult to capture and remember several types of feedback without video recording, throughout the interviews feedbacks were repeated out loud. In such cases, note-taking and photographs were also used as complementary techniques to prevent data loss. Otherwise, considering the importance of the naturalistic environment for the research and the research relationships, note-taking in the field was mostly avoided.

3.5.3. Transcribing the Data

Each interview session was transcribed verbatim to sustain the richness of the recordings for a comprehensive analysis of the qualitative data. Throughout the interviews, the participants did not complete their sentences occasionally; in such cases, words were added to their quotes to make them understandable or readable.

3.5.4. Data Analysis Methods: Content Analysis and Thematic Coding

The main considerations in the data analysis phase were enabling the interpretation of the data thoroughly for developing themes that were linked to the intensive resource consumption, and inferring relationships between those themes. Therefore,

inductive content analysis and thematic coding become productive approaches to categorise the qualitative data and make inferences from it (Figure 3.5).

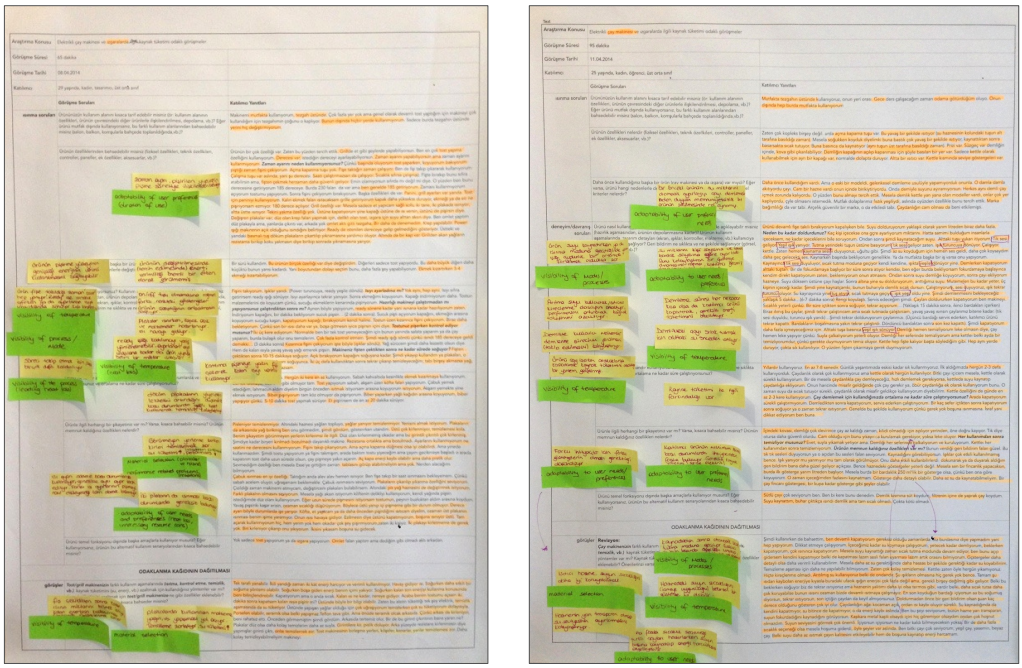

Figure 3.5: An image from the transcription and data analysis phase of the *primary research IIA: user observations on electric tea makers and contact grills.*

In this phase of the study a more comprehensive approach was adopted to analyse the interview responses. Each statement of the participants were categorised and then coded based on the emerging themes and subcategories within the data, namely process (use stages), related content (temperature, scaling) and nature of feedback (visual, auditory, tactile). Firstly, the researcher carried out the coding process to sustain consistency. Later, each code was examined several times for assessing the reliability of the codes. As the initial coding of the data proceeds, particular categories and themes emerged whereas several were altered or omitted (i.e. olfactory feedback). Afterwards, the categorised data was interpreted and the themes (considerations) related to the intensive resource consumption were developed for each category (Table 3.5).

Table 3.5: An example of the data analysis process from an electric tea maker case in user observations.

		Related Content		Nature of Feedback			
Use phases	**Observations/Interpretations/ Complaints/Appreciated Features**	Temperature	Scaling	Visual	Auditory	Tactile	**Themes**
filling the kettle	***observation:*** Considering the relatively large volume of the teapot, the participant filled the kettle up to maximum sign with purified water. ***interpretation:*** While adjusting water, the number of people for serving is not considered, and this results in overfilling the kettle. Inadequacy of the volume indicators in fulfilling the user needs can also contribute to the intensive water consumption. ***appreciated feature:*** Purified water prevents calcification and water boils quickly.			●			visibility of the scaling (in terms of adaptability of user needs and preferences)

3.6. Primary Research IIB: Generative Focus Group Sessions

After exploring use patterns of the participants in real-life context and gaining insights into the use behaviours leading to intensive resource consumption, it was aimed to collect multiple aspects relevant to research topic to complement the findings of the previous stages of the research. Focus group technique as a data gathering method offers opportunities for research studies in which the interaction and discussions between participants are essential (Glesne, 2011). Considering these, focus group sessions were facilitated to further discuss the users' experiences, strategies and insights regarding effective use of resources through a participatory approach.

In generative research studies, various tools and techniques including diary studies, cards for organising, categorising and prioritising ideas, cognitive mapping and collages can be adopted to explore individuals' latent knowledge and insights

(Hanington, 2007). Within the context of this research, generative tools such as *user diary* and *card sorting* were employed in the focus group sessions in order to acquire detailed information considering the particpants' experiences, and maintain the consistency with the previous stages of the research in which the use patterns are observed in real-life settings.

Explaining and describing experiences can be easier when individuals hear different or similar use behaviours and tactics (Ritchie & Lewis, 2003), which make focus group techniques preferable as a complementary method. The interaction between participants was also thought to be productive for creative thinking and development of strategies related to resource effectiveness. Another consideration for selecting focus group as a data collection method is that it is possible to gather a range of information relevant to the research topic in a short period of time.

This phase of the study is a part of a more comprehensive research (funded by TÜBİTAK, project no: 112M228) carried out with a research team namely SustainDRL involving a doctoral and a post-doctoral researcher and a project coordinator, and it focuses on both effective use of resources and product maintenance and repair for various small household appliances. Yet, with the aim of supporting the findings of the previous studies, only relevant products (i.e. electric tea makers and contact grills) and the phases of the relevant research were included in this thesis. This phase of the research consists of mainly four stages such as the development of the method, preparation, facilitating the sessions and the analysis phase (Figure 3.6).

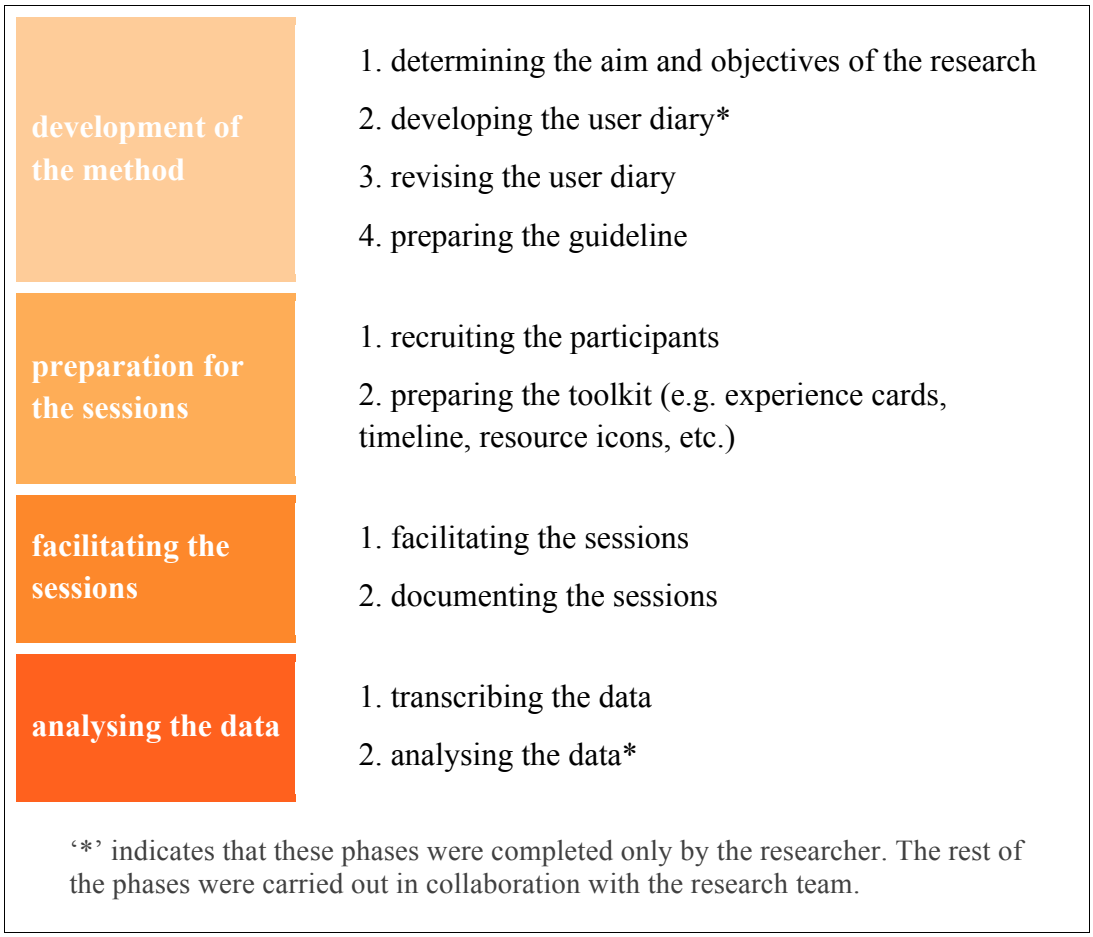

Figure 3.6: The stages of the generative focus group sessions and the role of the researcher.

3.6.1. Population and Sampling

In this study, being an experienced user of one the products of inquiry (i.e. electric tea maker and contact grill) was the primary selection criterion. Thus, snowball and availability sampling were used as a recruiting technique.

At the beginning of the study, a short recruitment invitation was published through the social media. The participants, who were interested in the study and fulfilled the selection criteria, were first contacted through email or phone to explain the aim of the research study and how they could contribute to it. Once receiving their approval to be a participant, the focus group sessions were scheduled.

Two sessions were conducted for each product case (i.e. electric tea maker and contact grill) with a group of participants ranging from 3 to 5. The study was

conducted with 15 participants in total, with ages ranging from 25 to 51 (Table 3.6 and Table 3.7). The researcher carried out the second session for electric tea makers separately.

Table 3.6: Participant information for electric tea maker sessions.

participants	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
age	26	25	37	31	53	28	51
gender	Female	Male	Female	Female	Female	Female	Female
occupation	chemist	research assistant	secretary	financier	accountant	biologist	teacher
product of inquiry	electric tea maker session I				electric tea maker session II		

Table 3.7: Participant information for contact grill sessions.

participants	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
age	26	38	31	58	53	29	32	25
gender	Female	Female	Male	Male	Female	Male	Female	Female
occupation	chemist	financial advisor	graphic designer	product designer	secretary	research assistant	UX designer	research assistant
product of inquiry	contact grill session I					contact grill session II		

3.6.2. Development of the User Diary

The focus group sessions were planned to be conducted in a controlled environment where it might be difficult to observe or talk about actual use behaviours. Also with the absence of their products, the participants might not remember clearly the stages of their use experience, and it might be problematic to capture the actual use patterns. Exploring use behaviours of the selected products was one of the main objectives of this thesis. To overcome the issues identified above, the researcher suggested to integrate a user diary (Figure 3.7) into the research process through which the participants write down their experiences with the product of inquiry regarding its

use phase on the given timeline prior to the sessions. Later, the user diary was revisied and finalized with the research team.

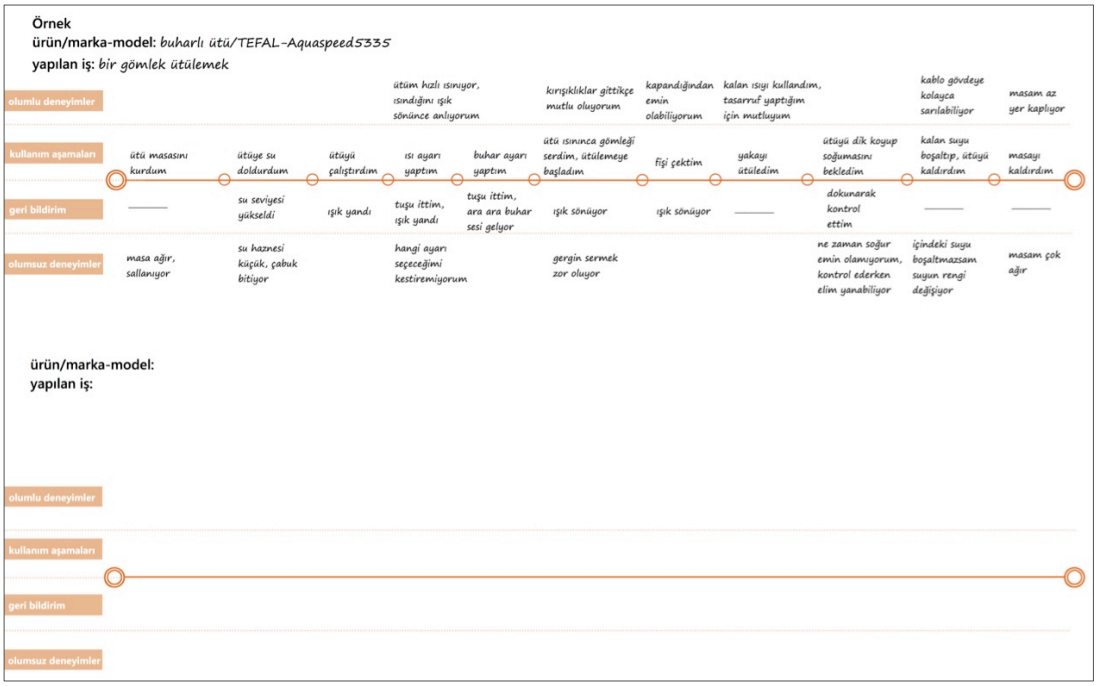

Figure 3.7: A user diary format as a generative tool used in the focus group sessions.

Diary methods require informants to record and describe their experiences considering a particular task, product or activities that they are engaged in throughout their daily life (Robson, 2002). The utilisation of user diaries as a data collection method enables comprehensive understanding of user behaviour through providing a record of thoughts and actions within the context.

While designing the diary, the simplicity and clarity were the main considerations to encourage respondents to participate in the task, since this generative tool would simply rely on their ability and motivation to fill in the information. Considering this issue, the participants were guided with the aid of an example (i.e. use phases of a steam iron) provided on the worksheet (Figure 3.7).

While delivering the diaries, the participants were asked to return them a few days prior to the focus group session. This was planned to help them to be able to participate in the discussions with a detailed understanding of their products. Also it would be possible to see the use patterns of the participants and explore the problem

areas related to resource consumption prior to the session in order to be well-prepared for probing these issues further. This method requires some effort from both the participant and the researcher, however it has the potential to influence positively the validity and reliability of the research.

3.6.3. Data Collection: Focus Group

Prior to the each session, the toolkit including experience cards, resource icons and a timeline were prepared with the research team. The returned diaries were analysed for the purpose of exploring use patterns, preparing experience cards and discussing them further on the session. Participants' experiences were transcribed on coloured papers that were printed out and cut into experience cards, and then distributed during the sessions (Figure 3.8). Later, based on the similar or different use phases a more inclusive timeline (Figure 3.9) was developed in order to guide the participants to organise and categorise their experiences through attaching the experience cards under the relavant use phases during the sessions.

On the day of the sessions, the participants were welcomed in a meeting room in YTM-MATPUM (a research centre in METU) and comforted with a warm-up conversation apart from the research topic. Later, a personal introduction was made and the purpose of the study was explained to the participants. The informed consent form (Appendix D) was provided, and their approval to participate in the research was granted.

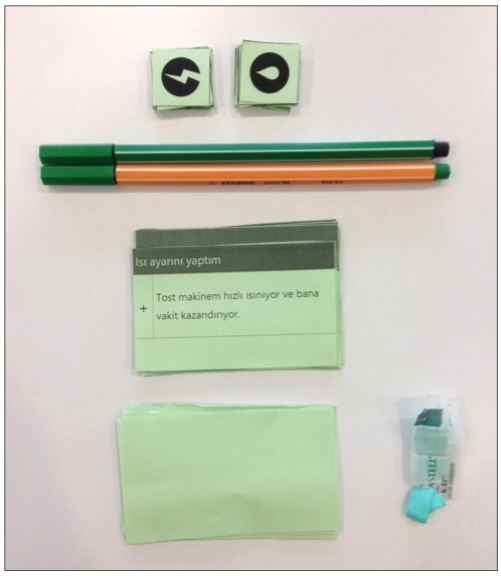

Figure 3.8: The toolkit provided during the focus group sessions including experience cards, resource icons, etc.

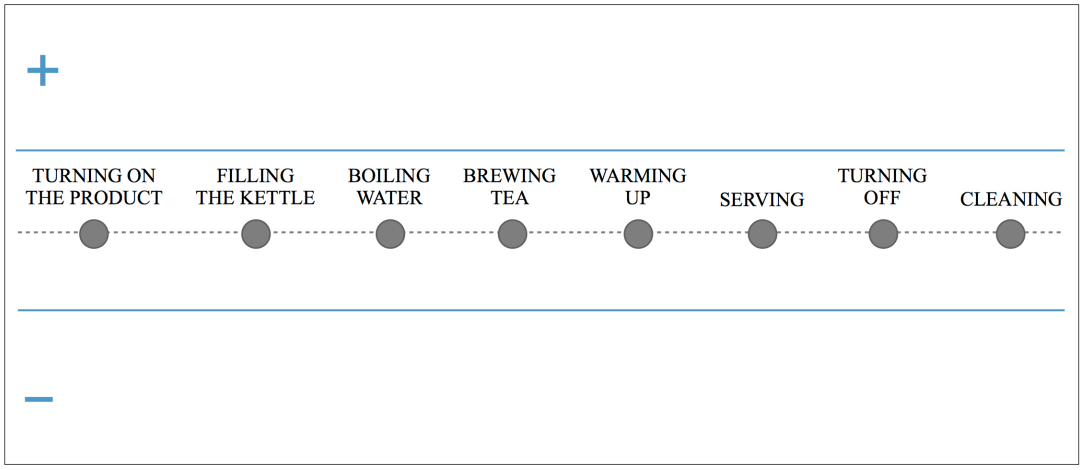

Figure 3.9: An example of the inclusive timeline adopted in the sessions to organise and categorise the experiences.

The focus group sessions comprised of three stages. In the first part of the session, the participants were asked to share their own experiences with their products and attach pre-prepared experience cards on the timeline under the relevant use phases (Figure 3.10). They were encouraged to discuss and comment about each other's experiences as well. The participants were also provided with empty cards to enable them to add new comments or experiences during discussions, and attach these on

the given timeline. In the second part of the session, the participants were asked to attach water and electricity icons under the relevant experiences that they thought these would consume resources intensively or unnecessarily. After placing the icons, they were requested to explain why they thought that particular phase would consume resources (water and/or electricity) unnecessarily. Finally, they were asked to share strategies that they adopted to reduce resource consumption and discuss about them. The focus group guideline can be found in Appendix D.

Figure 3.10: An image from the focus group session.

The discussions in the focus group have provided valuable information for the research. Being able to observe the intensity of identified problems, which were placed under different use phases on the timeline, perceiving the different as well as the similar concerns considering resource consumption was extremely useful for the study. The group members also stimulated new thoughts and strategies for each other. The sessions were audio and video recorded in order to analyse the information further in detail. The duration of sessions ranged from 60 to 70 minutes.

3.6.4. Transcribing the Data

The focus group sessions were transcribed through omitting several irrelevant data such the one occurred during the conversation between the respondents. Each

participant's responses were differentiated on the transcription with colour coding. In order to be able to identify the voices, the video recordings were tracked together with the audio recordings. The participants occasionally talked together or quite fast to express themselves that made it difficult to comprehend the words and transcribe them. Therefore, the recording was often listened twice to ensure accuracy.

3.6.5. Data Analysis Methods: Content Analysis and Thematic Coding

In the data analysis process it was aimed to comprehend and present the significant problem areas related to resource consumption mentioned by the participants and link them with the sustainability considerations to complement and support the findings of the previous research stages. Similar to the previous stages, inductive content analysis and thematic coding were adopted to categorise and interpret the qualitative data. Considering the aim and scope of the thesis and the consistency of the research findings, the researcher carried out the data analysis process separately, apart from the research team.

As analysing the data, the prominent use patterns leading to intensive resource consumption were categorised under the relevant use stages for each product case. Later, these patterns were linked to the considerations developed earlier. An example from the data analysis process can be seen in Table 3.8.

Table 3.8: An example of data analysis process from contact grill sessions.

Use phases	Findings & Interpretations	Themes
adjusting temperature	**findings:** Some of the participants have a presumption that through selecting higher temperatures, the appliance can warm up more quickly and accordingly consume significant energy. **interpretations:** Resource consumption in accordance with the cooking modes should be identified clearly to steer users towards effective use of resources	visibility of the resource consumption

3.7. Limitations of the Study

Throughout the user observations, the researcher played the role of the observer to maintain the naturalistic environment of the observations. However, through analysing the observations it was realised that motivations behind several use behaviour remained unknown (e.g. how they adjust the water level, determine the cooking mode, etc.), which might be named as a limitation of the user observations. To overcome this limitation, the second phase of the primary research was designed to be able to probe into the use behaviours more comprehensively.

During user observations and interviews with the aim of acquiring a reliable data, the expression 'resource consumption' was avoided. However, the presence of the researcher in the research setting might influence the participants' use patterns and biased the results as well. In order to deal with this limitation, the interviews were conducted like a conversation between two people rather than an exchange of questions and responses.

Apart from these, the final question of the user observations inquiring about the problem areas related to resource consumption and their suggestions to overcome these problems might be considered as a knowledge based question. Along with this, it was also observed that talking about resource consumption being mostly invisible in nature was challenging for the participants. To prevent these, the final question was rephrased in the following stages and a focusing paper was provided to inform the participants related to the environmental consequences of their use behaviour to ease responding the question. Furthermore, in the first two stages of the primary research, only female participants were reached based on their availability. This could also be considered as a limitation of the study, since the intuitive and/or habitual use patterns (e.g. cleaning patterns, etc.) linked to the intensive resource consumption might demonstrate differences in line with the gender of the poeple participated in the research.

In the final stage of the research, the implementation of the user diary method enabled the participants to record use patterns prior to the sessions, and provided the researcher with a wide range of data, however it also raised reliability concerns. In some cases, the gap between the informant performing the task and recording it

might affect the validity of the data. However, throughout the sessions, each use phase was mentioned referring to their statements in the diaries with the aim of verifying the user's experiences.

3.8. Conclusion

In this chapter, insights into the research approach and research process including the research design, data gathering, transcription and analysis of the data are presented. Each method used for data gathering (i.e. user observations, semi-structured interviews and focus group sessions including generative research tools) was interrelated through complementing each other at certain points. The observations enabled the researcher to explore the participants' intuitive use behaviours whereas the interviews allowed a detailed understanding of use behaviours through a series of follow-up questions and probes. The focus group sessions, in that sense, with the implementation of user diary tool provided both detailed and wide-ranging responses related to participants' use patterns leading to intensive and/or excessive resource consumption. Discussions in the sessions also allowed the researcher to see the similar as well as the diverse experiences among the similar or different products. These research studies might affect the participants' awareness and concern about the environmental consequences of their use behaviours, however the implications of this was not explored further as it was out of the research's scope. In the following chapters, the findings from and insights into the research stages will be presented in detail.

CHAPTER 4

PRELIMINARY STUDY AND PRIMARY RESEARCH I

This chapter presents the findings from and insights into the preliminary study and the *primary research I*. The first part delivers the results and conclusions from the *preliminary study* along with the definitions of sustainability considerations that have emerged throughout the study. The following section evaluates and explains the results of the p*rimary research I: user observations on various household appliances* in detail for each product case. The chapter concludes with the cross comparison of the findings from the product cases in line with the considerations and the overall conclusions from the first stage of the primary research.

4.1. Definitions of the Themes

In the data analysis process of the preliminary and the primary research stages, several considerations have emerged from the raw data that are relevant to the effective use of resources. The content of these themes have been generated through participants' responses and the researcher's observations in the field. In this regard, before presenting the findings of the research studies, the definitions of the sustainability considerations will be explained briefly in Table 4.1 for providing a better understanding.

Table 4.1: The definitions of the considerations related to the effective use of resources.

Considerations	Definition
Adaptability of user needs and preferences	Accommodating various requirements of users in the use phase of the product
Automation of the process	Performing the use phases (e.g. receiving water, stirring/mixing, cleaning, etc.) automatically through reducing the user involvement in the process
Ease of cleaning	Enabling and encouraging users to maintain the product properly and regularly through providing a convenient cleaning process (e.g. ease of access to the product's components, material and surface properties, etc.)
Structural effectiveness	Resource effectiveness and/or consumption resulting from the intrinsic properties of the product (e.g. insulation, material properties, etc.)
Transformation of user behaviours/habits	Transferring the habitual use behaviour associated with the old products intuitively into the new ones (e.g. use patterns adopted while boiling water with traditional tea pot and electric tea maker for brewing tea, etc.)
Visibility of the process/modes	Providing detailed and clear information relevant to the processes and different modes (e.g. warming up, boiling, baking, cleaning, etc.)
Visibility of the resource consumption	Providing information related to the aggregate resource consumption in the use phase of a product in comparison to the other use stages, other appliances or the overall domestic consumption
Visibility of the scaling	Providing clear and precise indicators for the accurate scaling of the resources (e.g. scaling water for brewing, etc.)
Visibility of the temperature	Communicating the temperature of a product and/or the resources (i.e. water) with clarity throughout the use stages

4.2. Preliminary Study

In this phase of the research, a user observation with an electric tea maker user was conducted through capturing the behaviours and use patterns around a product. The observation was complemented with and followed by a semi-structured interview for an in-depth understanding of the effective use of resources (i.e. electric and water) in the selected small household appliance.

The study was carried out prior to the primary research stages including the following purposes:

- to control the clarity of the interview questions;
- to determine the usefulness of the questions to acquire relevant data for the purpose of the study;
- to rehearse the flow of the interview schedule; and
- to determine how the data will be analysed.

4.2.1. Results of the Preliminary Study

Within the context of this study, an electric tea maker was observed in a single-parent household, and the interview was conducted with the participation of the female household member aged 44.

In the first phase of the interview (i.e. warm up questions), the participant explained the use environment and the features of the product along with her motivations for selecting that particular product. The product of inquiry boils the water as turning on the kettle and switches to keep warm feature automatically. Then, she brews the tea through pouring water into the teapot, and after a while tea is served. The product also provides a removable filter and light indicators for different modes (Figure 4.1). In the research setting, the product was placed on the kitchen counter, but was relocated to the kitchen table for an easy serving. As stated by the participant, it would also be used wherever the household or guests would gather such as in the balcony, living room or terrace. The results of the interview indicated that the energy effectiveness was not the concern of the participant while selecting this particular product.

Figure 4.1: The images from the preliminary study.

In the next phase, the participant brewed tea and the use stages were observed in detail. The analysis of the observation phase along with the interpretations and associated themes can be seen in Table 4.2 below.

Table 4.2: The analysis of the use phase for the preliminary study.

use phases	Observations & Interpretations	Themes
plugging in	***observation:*** The participant plugged in the product. ***interpretation:*** It does not inform the user whether it is properly plugged in.	visibility of the process/modes
filling water	***observation:*** Kettle was filled with water till the maximum sign, which is 1.8 litres. ***interpretation:*** Volume indicator on the kettle informs the user related to the water level, yet the amount of water that is required for brewing the tea is not clear. The kettle's reservoir enables the user to fill it up to 1.8 litres this may also be linked to overfilling the kettle.	visibility of the scaling
turning on & boiling	***observation:*** The product was turned on and the light indicator on the right turned to red. As boiling the water, click sound was heard. ***interpretation:*** Boiling process communicates with the user through a wide range of feedbacks (i.e. visual, auditory and tactile).	visibility of the process/modes

Table 4.2: The analysis of the use phase for the preliminary study (Cont.).

brewing	***observation:*** The teapot was filled with tealeaves with a spoon and then brewed until the maximum mark. ***interpretation:*** The transparency of the teapot along with the volume indicators on it ease scaling water for brewing.	visibility of the scaling
boiling & warming up	***observation:*** The water tank was refilled with water a bit lower than the maximum sign and the product was turned on. As boiling the water, it automatically switched to the keep warm mode, and the light on the lower left turned into red. ***interpretation:*** Keep warm mode enables the user to preserve the water at a certain degree rather than re-boiling it repeatedly and saves energy. Yet, through reducing user involvement in the decision making process it can also result in intensive resource consumption through leaving the appliance on for long durations.	visibility of the process/modes, visibility of the temperature, automation of the process
serving	***observation:*** After serving the tea for the second time, the participant added water slightly. ***interpretation:*** The kettle is refilled, even though the remained water may be sufficient for the further rounds.	visibility of the scaling
warming up & turning off	***observation:*** The product was operated on keep warm mode for almost one and a half hours. Later it was switched off and light indicators turned off as well. ***interpretation:*** Throughout this process, periodically people may stop drinking tea, however the product continues warming the water unnecessarily.	visibility of the temperature, visibility of the process/modes
cleaning	***observation:*** The teapot was rinsed off immediately. ***interpretation:*** Maintaining the appliance regularly prevents further stains and reduces water consumption in the cleaning process.	ease of cleaning
	observation: Water remained in the kettle was also emptied for cleaning considerations for the next use. ***interpretation:*** The calcification in the kettle results in using additional water for cleaning.	structural effectiveness, ease of cleaning
unplugging	***observation:*** As leaving the research setting, the tea maker was still plugged in. ***interpretation:*** The lack of feedback informing the process may cause leaving the product plugged in.	visibility of the process/modes

Regarding the use phase of the product, several findings have been highlighted related to the resource consumption and summarizied under the relevant categories namely *controls and indicators* and *cleaning*.

Controls and indicators: The volume indicator on the kettle provides insufficient

information about the water level in terms of the user needs (*visibility of scaling* and *adaptability of user needs and preferences*). It was observed that the user adjusted the water level without ensuring how much water was required for brewing tea. This results in overfilling the kettle and also refilling it unnecessarily in the following stages, and in turn consuming excessive water and electricity. Furthermore, the product does not inform the user whether it is plugged in/unplugged, which leads to leaving the product plugged in (*visibility of the process*).

Cleaning: The teapot is simply rinsed off, and this saves water consumption in the cleaning phase (*ease of cleaning*). Yet, the calcification within the kettle results in significant resource consumption (*structural effectiveness* and *ease of cleaning*).

Table 4.3: The analysis of the experience/behaviour question for the preliminary study.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "I use the product more than twice a day. If there are guests the duration of use differs considerably. In such cases, as the tea gets bitter, it is re-brewed instantly." ***interpretation:*** Along with the relatively long duration of use phase, the participant engages with the product quite frequently.	
complaints	***statement:*** "…as serving tea, significant amount of water is poured from the spout of the kettle…" ***interpretation:*** The user cannot pour the water into the teacup effectively due to the form of the kettle's spout, as a result it wastes water.	structural effectiveness

Table 4.3 above presents the analysis of the experience/behaviour question for exploring the participant's significant experiences with the electric tea maker. In this stage of the interview, the participant addressed the additional resource consumption resulting from the spilling of water as serving tea (*structural effectiveness*). In the final phase, the participant's suggestions for resource effectiveness within the use phase of the product were inquired. Table 4.4 below presents the insights into this question.

Table 4.4: The analysis of the user insights for the preliminary study.

	Responses & Interpretations	Themes
insights	***statement:*** "…after 45-50 minutes, tea loses it freshness but I cannot keep track of time especially in the presence of guests. The product might warn me somehow to inform whether the tea was fresh or not so that I could turn it off or pour the tea and re-brew it." ***interpretation:*** Being informed about the freshness of the tea could contribute to the resource effectiveness through preventing unnecessary use of the product.	visibility of the process/modes
	statement: "…it could warn me related to the temperature of the water and tea. I would rather drink tea that is extremely hot but others might prefer colder. Such information might enable me to serve tea for different needs." ***interpretation:*** Considering the different preferences of the people, temperature adjustment could also reduce excessive resource consumption through heating water to the desired temperature.	visibility of the temperature, adaptability of user needs and preferences

The design interventions suggested by the participant can be explained within the context of ***eco-feedback***. Former suggests an indicator about the freshness of the tea whereas the latter offers clear temperature indicator in line with the different preferences and needs, which can also contribute to the resource effectiveness through preventing overheating the water.

4.2.2. Conclusions and Insights from the Preliminary Study

The main emphasis in this study was revising and refining the interview guideline for the further phases of the study. The participant responded to the most of the interview questions easily. However, she hesitated as responding the final question, which might be comprehended as a knowledge question. Thus, the wording of the question was revised later for the *primary research I* (see Section 3.4.2). The observation phase was also quite productive for the exploration of the habitual use patterns around a product. However, after completing this preliminary study, it was realized that it could have been more useful to take notes during the observation phase to better investigate the use patterns through probing into them.

This section has presented the findings from and insights into the preliminary study. For the further phase of the research, several electrical household appliances were included in the study for enquiring into the reasons of excessive resource consumption. In the following section the results of the *primary research I* will be revealed.

4.3. Primary Research I: User Observations on Various Household Appliances

4.3.1. Aim and Context of the Study

In this phase of the study, considering their impact on domestic resource consumption eight electrical household appliances that are used frequently and/or for relatively long durations in domestic environments were selected to explore further. Use phases and activities around the products (i.e. *contact grill, Turkish coffee maker, mini oven, electric tea maker, bread maker, electric frying pan, steam generator iron and air humidifier*) were observed and followed by semi-structured interviews to better comprehend the patterns that would lead to excessive resource consumption. The user observations were carried out through home visits to be able to capture the use behaviours, even the habitual ones that would be performed with little deliberation and limited awareness in the actual use contexts. The detailed information about the participants can be seen in Table 3.2.

After collecting the data, the findings were organized by using the template developed for the analysis of the data. The following section presents the results of the user observations and interviews case by case. The findings from the product cases will be presented in line with the interview guideline, namely warm-up questions, observations (use phase), experience/behaviour and opinions/insights questions. The prominent findings will also be categorizied and summarizied based on the relevant categories such as *controls and indicators*, *heat loss* and *cleaning* for use phases and *eco-feedback* and *eco-steer* for insights to organize and introduce the particpants' responses and researcher's interpretations as clear as possible.

4.3.2. Results of the User Observations and Interviews

4.3.2.1. Case 1: Contact Grill

Contact grills are commonly used in Turkish households for various purposes including toasting, grilling and warming up foods. In this study, the product was observed in a bachelor household and the interview was conducted with a female student aged 22.

The product of inquiry has three modes for adjusting heat, a light indicator, removable plates and a tray for easy cleaning (Figure 4.2). As stated by the participant, the appliance is often used in the kitchen, unless the grilling function is utilised. In such cases, the product is placed in the balcony or in front of the kitchen window, since it releases intense smoke and smell. It could be interpreted that the energy efficiency was not the primary concern of the participant while selecting that particular product, rather it was preferred mainly for its grilling function.

Figure 4.2: The images from the use phase of the contact grill.

In the following phase the participant prepared a sandwich with the product and the use stages were observed in detail. The analysis of the observation phase is presented in Table 4.5 below.

Table 4.5: The analysis of the use phase for the contact grill.

use phases	Observations & Interpretations	Themes
turning on & warming up	***observation:*** The participant plugged in the grill, light indicator turned to red and the product started to warm up. ***interpretation:*** The light indicator may be misleading, since it both informs that the product is plugged in and turned on.	visibility of the process/modes, visibility of the temperature
selecting modes	***observation:*** The participant did not change the pre-adjusted temperature. ***interpretation:*** The product does not offer precise and clear temperature adjustment, which may lead to overheating and intensive resource consumption.	visibility of the temperature
preparation	***observation:*** Baking paper was placed between the heating plates in order not to clean the whole product. ***interpretation:*** Baking paper eliminates the need for cleaning the plates frequently. Yet, its utilisation consumes additional resource.	ease of cleaning
	observation: Sandwiches were prepared as the appliance was warming up. Later, they were placed on the heating plates. ***interpretation:*** It is difficult to detect the temperature of the heating plates. Consequently, the appliance may warm up more than needed and consume significant energy throughout the preheating process. Along with this, the need for preheating appears to be also questionable.	visibility of the temperature
warming up	***observation:*** When the pre-adjusted temperature is reached, the light indicator turned off together with a click sound. ***interpretation:*** Feedback may misinform the user related to the use phase and the temperature of the grill. It becomes difficult to comprehend whether the product is turned off or still warming up.	visibility of the process/modes, visibility of the temperature
	observation: As controlling the sandwiches, the participant raised the temperature and the light turned on again. The food was checked twice to determine if it was ready. ***interpretation:*** The product does not inform the user related to the approximate cooking duration of diverse foods. Controlling or checking the food whether it is ready or not leads to considerable heat loss.	visibility of the process/modes, adaptability of user needs and preferences

Table 4.5: The analysis of the use phase for the contact grill (Cont.).

turning off	***observation:*** When the sandwiches were toasted, the participant unplugged the product, light turned off and the sandwiches were removed. Upper heating surface was left in an open position until it got relatively cold. ***interpretation:*** As it is unplugged, the temperature of the heating plates remains unknown. Thus, the residual heat is consumed ineffectively.	visibility of the temperature
cleaning	***observation:*** The participant cleaned neither the heating plates nor the tray. They were stated to being cleaned quite rarely. The baking paper was also left inside the grill for further uses. ***interpretation:*** The utilisation of the baking paper reduces the amount of water consumed during the cleaning phase.	ease of cleaning

Regarding the use phase of the contact grill, several issues have been highlighted as relevant to the excessive resource consumption that can be summarized under the related categories, namely *controls and indicators*, *heat loss* and *cleaning*.

Controls and indicators: The light indicators may misinform the user about the process (i.e. warming up or turned off) along with the temperature of the heating plates, and this results in warming up the product unnecessarily and consumes significant energy *(visibility of the process/modes and visibility of the temperature)*. Along with these, the product does not provide precise temperature adjustment. It represents modes through numbers (i.e. 1, 2 and 3), yet the relation between the temperature and its corresponding number is not identified clearly. Consequently, this leads to selecting undesired modes and in turn increases energy consumption (*visibility of the temperature*).

Heat loss: Throughout the use phase of the product, considerable amount of heat loss was observed as a consequence of the use behaviours and the structural properties of the product. Firstly, while checking the food, the participant raised the grill's lid twice, and this led to significant heat loss (*visibility of the process/modes*). The plates were mentioned to get warm quickly, whereas cooling down relatively slow. Consequently, after unplugging the product, the lid was left open to cool the product down, and the residual heat was not consumed effectively (*visibility of the temperature*). Along with these, throughout the use phase intensive heat was also lost

as a result of the openings from the sides of the heating plates (*structural effectiveness*).

Cleaning: Foods are stuck on the plates under high temperatures and this increases water consumed during the cleaning phase. Considering this, the participant developed a strategy and placed a baking paper between the plates that resulted in effective use of water throughout this phase (*ease of cleaning*).

In the following question, the participants' main experiences with the product were inquired to comprehend the problem areas identified by the user. Table 4.6 below presents the analysis of the data derived from this question.

Table 4.6: The analysis of the experience/behaviour question for the contact grill.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "…it is used at least twice a day and sometimes even more..." ***interpretation:*** The participant engages with the product quite frequently.	
complaints	***statement:*** "…Since the technical service changed the resistance, the grill gets warm quickly but it cools down quite slowly. Even ten minutes after unplugging, it is still hot to touch. If I left something in it while cooling, it would most probably burn out." ***interpretation:*** The absence of a feedback related to temperature of the plates after unplugging leads to ineffective resource consumption.	visibility of the temperature, structural effectiveness
	statement: "…I mostly do not change the temperature mode, it is always at the lowest one… I am not sure how the temperature adjustment affects the duration. As I do not want to burn the food, instead I wait longer…" ***interpretation:*** The relation between the cooking mode and the duration of use is not clearly identified and relevant feedback is not provided.	visibility of the temperature

Gaining insight into the use experiences of the participant, several problem areas were identified all of which were linked to the visibility of the temperature. For instance, the participant mostly selects the lower temperature adjustment, and relates this behaviour with the unclear correlation between the temperature and the duration

of cooking. Also the heat of the plates was stated to remain unknown, and that was considered as the reason for ineffective use of the heat after unplugging the product.

Table 4.7: The analysis of the insights for the contact grill.

	Responses & Interpretations	Themes
insights	***statement:*** "…a timer, similar to the one that my oven has, might be quite useful in grills. When the pre-adjusted time is reached, it may turn itself off automatically." ***interpretation:*** Adjusting time may reduce resource consumption through preventing unnecessary use of the product. Yet, it may decrease the level of user engagement with the process, and through forgetting the task, it can eventually lead to an increase in resource consumption.	visibility of the process/modes, automation of the process
	statement: "…the grill somehow could show the remaining time till the product gets cold after unplugging. Then, I might use the heat more effectively for toasting leftover breads and such." ***interpretation:*** Informing user related to the remaining heat potentially encourages them to use the heat effectively.	visibility of the temperature, visibility of the resource consumption
	statement: "…the appliance may warn me while it is warming up in the absence of any food on the heating plates, so that I might reduce the preheating duration and even eliminate it and prevent unnecessary resource consumption." ***interpretation:*** Constraining the undesired behaviour through design interventions, which is preheating in this case, can enable resource effectiveness.	visibility of the process/modes

In the final question participant's suggestions for the resource effectiveness in the use phase of the appliance were explored (Table 4.7). The responses can be organised under two categories based on the nature of the suggested design interventions, namely *eco-feedback* and *eco-steer*.

Eco-feedback: Considering the importance of being informed about the process, the participant suggested the incorporation of a timer into the contact grill. Remaining heat could be represented through the timer for an effective use of the residual heat. It was also stated that adjusting the timer could enable turning off the product automatically and prevent excessive resource consumption.

Eco-steer: Another suggestion developed by the user was related to embedding the desired behaviour into the product to prevent excessive resource consumption resulting from the preheating phase.

4.3.2.2. Case 2: Turkish Coffee Maker

Turkish coffee makers have been a preferred alternative to the conventional coffee pots in Turkish households. Within the context of this study, the product was observed in a family household and the interview was conducted with the female household member aged 48.

The process of coffee preparation is considerably automated within this product, for instance the water is received automatically and a wide range of feedbacks (i.e. auditory, tactile and visual) related to the process is provided for the user. It also offers an on/off button, a dosage adjustment button, a removable water tank, and a measuring spoon (Figure 4.3). The product of inquiry is located on the dishwasher along with a couple of kitchen appliances. The participant prefers that particular product, since it prevents overflowing, which is stated as being the most common accident that occurs during preparing Turkish coffee and directly affects the water consumed throughout the cleaning process.

Figure 4.3: The images from the use phase of the Turkish coffee maker.

In the next phase, the participant prepared a coffee for two, and the use stages were observed in detail. The analysis of the observation phase can be seen in Table 4.8 below.

Table 4.8: The analysis of the use phase for the Turkish coffee maker.

use phases	Observations & Interpretations	Themes
plugging in	***observation:*** The product was already plugged in as entering the research setting. ***interpretation:*** The product is always left being plugged in. The absence of any form of feedback can be related to this habitual behaviour.	visibility of the process/modes
turning on	***observation:*** The participant turned on the product and the light indicator on the middle turned to blue. ***interpretation:*** The light indicator informs the user clearly about the process.	visibility of the process/modes
preparation	***observation:*** Coffee was added with the product's measuring spoon. ***interpretation:*** The measuring spoon eases scaling the coffee.	visibility of the scaling
warming up	***observation:*** Placing the coffeepot onto its spot, the participant selected the dosage. The light above the coffeepot turned to blue, and the product started to get warm with an intense sound. ***interpretation:*** Feedbacks (i.e. sound and light) provided in this phase enable the user to follow the process.	visibility of the process/modes
	observation: Product received water from the reservoir. ***interpretation:*** The automatic adjustment of the water in accordance with the selected dosage can reduce unnecessary water consumption.	visibility of the scaling, automation of the process
	observation: As receiving water, the blue light in the middle turned to pink and started blinking indicating that the remaining water would not be sufficient for the further uses, and it would need to be refilled. ***interpretation:*** Besides the feedback, controlling the water level is quite difficult due to the position of the reservoir.	visibility of the scaling, visibility of the process/modes, automation of the process
serving	***observation:*** When the coffee was ready, beep sound along with a blinking light above the pot informed the user. As removing the coffee pot, the sound stopped and the user served the coffee. ***interpretation:*** The frequency and the sound level of the feedback enforce user to remove the pots and turn the product off, this in turn reduces resource consumption.	visibility of the process/modes

Table 4.8: The analysis of the use phase for the Turkish coffee maker (Cont.).

cleaning	***observation:*** The participant cleaned the coffee pots with detergent and water whereas the user would clean it once a week with a wet cloth, as it would get dusty. ***interpretation:*** Material applied inside the coffeepot prevents sticking, so that the dried coffee is cleaned easily and this reduces water use in the cleaning process.	ease of cleaning
turning off	***observation:*** While placing the pots back to the product, the user realized leaving the product turned on and she turned it off. Intensive blue light above the heating station and the light indicator turned off as well. Yet, the product remained plugged in. ***interpretation:*** The participant forgets to turn the product off despite the intensive light indicator. In this regard, the nature of feedback (i.e. visual) appears to be insufficient.	visibility of the process/modes

Regarding the use phase of the product several interpretations have been emphasized related to the resource consumption that can be reviewed as follows:

***Controls and indicators*:** While entering the research setting, it was observed that the product was already plugged in, and after the use stage, the participant did not unplug it as well. This habitual behaviour may be linked to the absence of clear information related to the use stage (*visibility of the process*). After preparing the coffee, the product was left turned on for a period of time. Considering this, the related feedback should appeal to more senses to encourage users to consume resources more effectively (*visibility of the process*). Besides these, the controls and indicators are used quite effectively within this product for informing user about the process and achieving effective use of resources. For instance, the product receives water in accordance with the selected number of cups automatically, and this contributes positively to the water consumption (*automation of the process*). The low level of water is also notified through the blinking light (*visibility of the process* and *visibility of the scaling*).

Cleaning: The technology embedded in the product prevents overflowing, and the material applied inside the coffee pot eases cleaning. Therefore, it can be interpreted that the structural properties of the product enable the user to use water effectively during the cleaning phase (*structural effectiveness* and *automation of the process*).

Table 4.9: The analysis of the experience/behaviour questions for the Turkish coffee maker.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "I use the coffee maker once or twice a day depending on the circumstances." ***interpretation:*** The duration of use is relatively short ranging between 1.5 to 3 minutes, yet it is used quite frequently. In the presence of guests, this number increases.	
appreciated features	***statement:*** "…The coffee maker each time receives required amount of water automatically, I do not have to adjust the water level…" ***interpretation:*** Automatic scaling of the water in line with the selected amount reduces unnecessary water consumption.	visibility of the scaling, automation of the process
	statement: "…fairly loud beep sound suggest that the coffee is ready and I remove the coffee pots…" ***interpretation:*** Informing user related to the process encourages reducing energy consumption.	visibility of the process/modes
	statement: "…it also prevents overflowing while saving time…" ***interpretation:*** Preventing overflowing decreases the amount of water consumed during cleaning phase.	ease of cleaning
accidents	***statement:*** "Several times, I filled the coffee pot with water unconsciously before turning it on. As the product started to run it received water again and the coffee spilled over. However quite a while, I blamed the product for receiving water twice until realising that it was my fault." ***interpretation:*** Transferring habitual use behaviour into the new products may result in excessive water and energy consumption.	visibility of the scaling, automation of the process, transformation of user behaviours/ habits

Table 4.9 above presents the analysis of the experience/behaviour questions for inquiring into the participants' significant experiences with the product. In this stage of the interview, *visibility of the process*, *ease of cleaning* and *automation of the process* for receiving water and preventing overflowing were all mentioned as the appreciated features of the product, which would also contribute considerably to the effective use of resources. However, considering the accident that the user experienced (i.e. filling the coffee pot despite the automatic receiving of water), transferring habitual use behaviours (i.e. conventional coffee preparation process)

into the new products (i.e. automated process) could be problematic and could result in excessive resource consumption.

Table 4.10: The analysis of the user insights for the Turkish coffee maker.

	Responses & Interpretations	Themes
insights	***statement:*** "…I mostly turn on the coffee maker and later add coffee into the coffee pot. Yet, quite often I delay the process and the appliance remains turned on unnecessarily. In that sense the product somehow encourages me to turn it on after completing the preparation." ***interpretation:*** Constraining the unintended behaviour (i.e. leaving the product on stand-by mode) can prevent unnecessary and intensive resource consumption.	visibility of the process/modes

In Table 4.10 above, the participant's suggestions for the resource effectiveness in the use phase of the product are presented. The design intervention suggested by the participant can be categorised under the notion of ***eco-steer***. The user indicated that the product might steer user to turn it on after completing the preparation (i.e. adding coffee and sugar) and placing the coffee pot back. In this regard, the resource consumption resulting from leaving the product on could be reduced considerably.

4.3.2.3. Case 3: Mini Oven

Mini ovens are quite common in Turkish households and may lead to intensive energy consumption in the use phase depending on the frequency of use. In this stage of the research, the user observation was conducted in a single-parent household with the participation of the female householder aged 50.

The product of inquiry offers three cooking modes, temperature adjustment, a timer and light indicators (Figure 4.4). The mini oven was placed on a kitchen shelf next to the refrigerator, and the user would use it on the terrace as well. The participant prefers this product due to the homogenous heat distribution, even though she has a newer and technologically advanced oven as well.

Figure 4.4: The images from the use phase of the mini oven.

In the following stage, the participant baked a cake and the use stages were observed for a better understanding of use behaviours around the product. Table 4.11 below presents the findings from the observation phase.

Table 4.11: The analysis of the use phase for the mini oven.

use phases	Observations & Interpretations	Themes
plugging in	***observation:*** While preparing the cake, the participant plugged in the product and the light on the lower right turned to red. ***interpretation:*** Light indicator may encourage users to unplug the product when it is not in use.	visibility of the process/modes
selecting modes & turning on	***observation:*** Temperature was adjusted and cooking mode (lower heating) was selected. As adjusting the timer, the light on the lower left turned to red, the light inside the oven was turned on, and the oven started to warm up. ***interpretation:*** The light inside the oven enables the user to check the food without opening oven's door, and in turn this reduces the heat loss. However, the light always stays on, as the mini oven starts to warm up, and the user does not have any control over it, which leads to further resource consumption.	adaptability of user needs and preferences
preheating	***observation:*** The oven was preheated for approximately 7-8 minutes. Later, the cake dough is placed into the oven. ***interpretation:*** The duration of the preheating process is adjusted intuitively. Throughout the preheating, considerable amount of energy is used, and the implications of this consumption for the whole use remain unknown.	visibility of the temperature, visibility of the resource consumption

Table 4.11: The analysis of the use phase for the mini oven (Cont.).

warming up	***observation:*** When adjusted heat was reached, the light on the lower left turned off. After a while the participant altered the cooking mode. ***interpretation:*** The feedback related to the thermostat temperature can be misleading, and this can be considered as the product is turned off whereas it continues warming up.	visibility of the process/modes, visibility of the temperature
controlling	***observation:*** The participant checked the cake twice through opening the door. ***interpretation:*** Opening the door for checking food results in considerable amount of heat loss.	visibility of the process/modes
unplugging & cooling down	***observation:*** As removing the cake, the user unplugged the oven. The light on the lower right turned off. In order to make use of the heat, the participant placed home-baked bread into the oven. ***interpretation:*** The heat can be used effectively during the cooling process for warming up other foods. This behaviour is performed intuitively, even though the residual heat is relatively invisible.	visibility of the process/modes, visibility of the temperature
cleaning	***observation:*** The participant did not clean the oven, since nothing has spilled inside. Yet, as stated by the participant, it is often cleaned with wet cloth and detergent while it is still warm. ***interpretation:*** It gets difficult to remove the stains as they get dried, thus the user prefers to clean the product while it is still warm which reduces water consumed in the cleaning process. Yet, it is relatively difficult to access the product's inner parts while cleaning.	ease of cleaning

The findings from and insights into the use phase of the product can be summarized as follows:

Controls and indicators: The light inside the oven enables the user to follow the process without opening the oven's lid. Yet, it stays on throughout the process and the user cannot turn it off, and this ends up with excessive resource consumption (*adaptability of user needs and preferences*). Additionally, the light indicator (i.e. thermostat light) may be misleading for the user, as it turns off when the pre-adjusted heat is reached and/or the product is turned off, and thus it may lead to consume energy unnecessarily (*visibility of the process* and *visibility of the temperature*). Along with this, the duration of the preheating process is adjusted intuitively, and

this may also result in warming up the oven unnecessarily and increase in energy consumption (*visibility of the temperature*).

Heat loss: Throughout the baking process, opening the mini oven's door for controlling food was considered as one of the major behaviour patterns that resulted in additional energy consumption. Thus, *the visibility of the process* in mini oven appears to be important to prevent heat loss. Another use behaviour leading to heat loss occurs while cooling down the oven. Although, in this case, the participant utilised the energy effectively during cooling process, the product would not encourage user towards such behaviour (*visibility of the temperature*).

Cleaning: Foods dry and stick on the oven's inner surfaces under high temperatures, which increase water consumption throughout the cleaning phase (*ease of cleaning*).

Table 4.12: The analysis of the experience/behaviour questions for the mini oven.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "I use mini oven once or twice a week except for the special occasions. I prefer to use it only when it is necessary otherwise, I feel it consumes too much energy." ***interpretation:*** The participant believes that the oven consumes too much energy, since it warms up quite a large volume with high degrees, and thus prefers to use it occasionally.	visibility of the resource consumption
complaints	***statement:*** "The sealing around the door often dislocates thus the oven warms up slowly." ***interpretation:*** The insulation around the door can contribute considerably to the energy effectiveness.	structural effectiveness
	statement: "…it turns off when the timer is off. If I adjust the time less than the required, it turns off unexpectedly and cause unintended results. In the exact opposite case, it may result in burning the food." ***interpretation:*** In the absence of an on/off switch, the user depends on the timer for turning off the product automatically. However through limiting the user involvement in the process, the use phase may also result in intensive resource consumption.	automation of the process

In the following phase, the participant's significant experiences with the product were explored (Table 4.12). The results reveal that considering the oven consumes

too much energy, the user prefers to use the product rarely (*visibility of the resource consumption*). The findings from the question also indicate that the heat loss resulting from the sealing around the door (*structural effectiveness*) and automatic shut off feature (automation of the process) are the significant aspects that may also result in excessive energy consumption.

Table 4.13: Analysis of the user insights for the mini oven.

	Responses & Interpretations	Themes
insights	***statement:*** "…Opening oven's door for checking food leads to heat loss. Instead the food should be more visible to prevent heat loss. Maybe the oven could sense whether the food was cooked and would inform me accordingly." ***interpretation:*** Visibility of the food along with the feedback related to its cooking degree and time can contribute to the effective use of resources.	visibility of the process/modes

The findings from the final question for mini oven can be seen in Table 4.13 above. The design intervention suggested by the participant can be considered as the implementation of ***eco-feedback*** strategy. The participant suggests a feedback for receiving detailed information related to the baking process for reducing the need of opening the mini oven's lid and preventing heat loss.

4.3.2.4. Case 4: Electric Tea Maker

A wide range of electric tea makers are being used in Turkish households as an alternative to the conventional teapots. Along with its common usage, the product is operated for relatively long periods, which contributes considerably to the domestic resource consumption. The product of inquiry was observed in the household of an elderly couple and the female household member with the age of 58 participated in the study.

The tea making process is rather simple within this product. When turned on, it boils the water and shuts down automatically. Then, the tea is brewed through pouring the water into the teapot. The heating plate keeps the teapot warm, while the water inside

the kettle is re-boiled repetitively (Figure 4.5). As stated, the product is mostly used on the kitchen table, but stored in the kitchen cupboard. The participant prefers to have that particular product, as it is portable and offers easier tea preparation and serving experience. In this regard, energy efficiency was not the primary concern of the participant in purchasing the product.

Figure 4.5: The images from the use phase of the electric tea maker.

In the use phase of the product, the participant brewed tea and the use stages (e.g. boiling, brewing, serving, cleaning, etc.) were observed in detail. Table 4.14 presents the comprehensive analysis of the use stages for the product.

Table 4.14: The analysis of the use phase for the electric tea maker.

use phases	Observations & Interpretations	Themes
filling the kettle	***observation:*** The participant filled the kettle above maximum level with water. ***interpretation:*** The product does not clearly communicate the water level in line with the requirements of the user.	visibility of the scaling, adaptability of user needs and preferences

Table 4.14: The analysis of the use phase for the electric tea maker (Cont.).

plugging in	***observation:*** The product was plugged in with the absence of any form of feedback. ***interpretation:*** It does not ensure the user whether it is plugged in properly.	visibility of the process/modes
turning on & boiling	***observation:*** The kettle was turned on through pushing the button on the kettle's handle. When the water was boiled, it turned off automatically along with a click sound. ***interpretation:*** The sound feedback received as the product is turned off appears to be instant which is difficult to notice or hear from a distance. It can appeal to more senses for effective feedback.	visibility of the process/modes
brewing	***observation:*** The participant added tea pouches into the teapot and brewed the tea. ***interpretation:*** Transparent material selection of the teapot eases to observe the brewing process. Yet, the water for brewing tea is adjusted intuitively.	visibility of the process/modes, visibility of the scaling
boiling	***observation:*** As brewing the tea, the user refilled the kettle fully and turned it on to boil the water. ***interpretation:*** It takes almost 20 minutes for tea to brew. Thus, it is unnecessary to heat the water, since it can get cold in the mean time.	visibility of the scaling, transformation of user behaviours/ habits, visibility of the process/modes
brewing	***observation:*** After 10-15 min, the participant observed that the tea was brewed. ***interpretation:*** Even though the transparency of the teapot enables user to follow the brewing process, it requires an experience in tea preparation to determine whether the tea is ready or not.	visibility of the process/modes
re-boiling & serving	***observation:*** The user re-boiled the water just before serving the tea. This pattern was repeated each time while serving. ***interpretation:*** In some cases, water inside the kettle may be hot enough to drink. However, due to the lack of clear temperature indicator, the user re-boils the water repetitively.	visibility of the temperature
turning off & unplugging	***observation:*** Approximately after 80-90 minutes, the participant turned off the switch. The orange light turned off. The product was unplugged. ***interpretation:*** The product does not clearly inform the user when it is left plugged in.	visibility of the process/modes

Table 4.14: The analysis of the use phase for the electric tea maker (Cont.).

cleaning	***observation:*** The teapot and the removable filter were cleaned immediately to prevent further stain. ***interpretation:*** Maintaining the product properly, eases cleaning process and reduces water consumption considerably.	ease of cleaning
	observation: Outside of the kettle is stated to be cleaned after every few uses, since it gets dusty or stained in the kitchen environment, whereas the inside is not cleaned quite frequently despite the intensive calcification. ***interpretation:*** If the participant does not maintain the kettle regularly and properly, this behaviour pattern may lead to calcification, which directly affects product's performance along with the energy consumption.	structural effectiveness, ease of cleaning

Several concerns have emerged as inquiring into the use behaviours that can be summarizied as follows:

***Controls and indicators*:** In conventional tea makers, steam from the boiling water heats the teapot. Within this product, despite the existence of a separate heating coil for the teapot, the user transforms this habitual behaviour into the product and boils water unnecessarily as the user brews tea (*transformation of user behaviours/habits*). Besides that, the electric tea maker provides a volume indicator for adjusting water level however, it is often difficult to judge how much water is actually needed such as how many people will drink tea or how many cup of tea will be consumed (*visibility of the scaling*). This results in boiling more water than needed, and also leads to significant water and electricity consumption. Besides, due to the lack of temperature adjustment, each time water is warmed up to the boiling point, although it is not preferred or needed (*visibility of the temperature*). It can also be interpreted that the product does not provide adequate information related to the use stages including; plugging in, boiling, brewing (*visibility of the process*) which can also cause excessive resource consumption.

Cleaning: Maintaining the teapot properly through preventing tea stains reduces the water consumption in the cleaning process. However, as the kettle is not cleaned regularly, calcification is built up inside the kettle, which directly affects the product's performance (i.e. water boils in a longer period of time), and in turn

increases the resource consumption (*structural effectiveness* and *ease of cleaning*).

Table 4.15: The analysis of the experience/behaviour questions for the electric tea maker.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "When I first bought it, I used it more than twice a day, however nowadays I use it once a day unless there are guests." ***interpretation:*** Although the participant uses the appliance less frequently, it is still operated for relatively long durations.	
appreciated features	***statement:*** "…compared to the conventional methods, the product prepares tea quite faster and the removable filter eases cleaning…" ***interpretation:*** The participant only rinse off the teapot without using detergents or chemicals.	ease of cleaning
complaints	***statement:*** "…it is exhausting to reheat the water every time before pouring tea…" ***interpretation:*** The temperature of the water is unknown and the product does not provide a keep warm feature, thus the water is re-boiled repetitively, which consumes resources intensively.	visibility of the temperature
	statement: "…While heating water for soups or meals, I hear the boiling sound and immediately turn off the kettle before it boils." ***interpretation:*** Product does not offer temperature adjustment, thus the participant develops some intuitive methods to adapt the product to her needs, and thus saves energy.	visibility of the temperature, adaptability of user needs and preferences
	statement: "…When I have guests we drink tea for hours and consequently I brew tea more than once. In the end, I mostly forget to turn it off, and it keeps warming up the tea while none of us drinking." ***interpretation:*** The absence of clear feedback related to the brewing process leads to excessive resource consumption.	visibility of the process/modes

Later for a detailed understanding of the participant's overall use experience, experience/behaviour questions were inquired (Table 4.15). In this phase of the study, the participant mentioned *ease of cleaning* as the appreciated feature of the product, which would also reduce water consumption within this process. Reheating water repetitively (*visibility of the temperature*), the absence of temperature

adjustment (*adaptability of user needs and preferences*), and the *visibility of the process* were mentioned as the negative experiences associated with the product, all of which could also lead to intensive resource consumption.

Table 4.16: The analysis of the user insights for the electric tea maker.

	Responses & Interpretations	Themes
insights	***statement:*** "While engaging other chores in the household, I often forget that I brewed tea and it warms up unnecessarily. The product, for instance inform me as the tea is brewed so that I can use energy effectively." ***interpretation:*** Informing users regarding the brewing process can lead them to use resources effectively.	visibility of the process/modes
	statement: "…if I knew how using tea maker affects my electricity bill, I might use it more consciously." ***interpretation:*** The user is concerned about the overall resource consumption throughout the use phase of an electric tea maker.	visibility of the resource consumption

Finally, considering the use phase, the participant's suggestions for the resource effectiveness in the use phase of the product were investigated (Table 4.16). Both of the design interventions suggested by the participant can be explained within the context of ***eco-feedback*** as each intends to achieve effective use of resources through being informed about the use experience. Former intervention can be defined as informing the user about the use stages (i.e. brewing) whereas the latter emphasises providing feedback regarding the energy consumption within these stages in comparison to the overall domestic energy consumption.

4.3.2.5. Case 5: Bread Maker

Bread makers as practical cooking appliances are utilised in households for preparing homemade breads. Within the context of this study, the product was observed in a family household with the participation of the female household member aged 31.

In this product, the process of bread making is considerably automated and consequently requires little user involvement. It offers a wide range of alternatives to fulfil the preferences and needs of the user including various baking modes,

temperature adjustment for desired crust options, bread size selection and 12-hour delay timer for baking bread at any time. Along with these, a variety of feedbacks (i.e. auditory, tactile and visual) related to the process is provided for the user (Figure 4.6). In the research setting, the product was placed on the kitchen counter, however when not in use, it is stored into its protective box. It can be indicated that the participant was not concerned about energy effectiveness while selecting this particular bread maker.

Figure 4.6: The images from the use phase of the bread maker.

In the use phase, the participant baked double loaves of bread, and the use stages were observed in detail. The interpretation of the observation phase can be seen in Table 4.17 below.

Table 4.17: The analysis of the use phase for the bread maker.

use phases	Observations & Interpretations	Themes
preparation	***observation:*** To prepare different types of bread, the user placed double loaf bread pan inside the product. Later, rubbing blades with oil, they were attached into the chamber and later ingredients were added into the bread pan. ***interpretation:*** As adding ingredients, some may pour into the chamber. The dirt accumulated on the resistance directly affects the performance of the product, and the resource consumption.	structural effectiveness, ease of cleaning
	observation: The cover with two transparent hoops was closed and click sound was heard. ***interpretation:*** The transparent cover enables the user to follow the stages easily. Yet, since the product is highly automated, it limits user engagement throughout the process.	visibility of the process/modes

Table 4.17: The analysis of the use phase for the bread maker (Cont.).

plugging in	***observation:*** The participant plugged in the bread maker and the display was lighted up together with a beep sound. After 30 seconds the light and the sound turned off. ***interpretation:*** Continuous feedback communicates clearly related to the process and can prevent leaving the product plugged in unnecessarily.	visibility of the process/modes
selecting modes	***observation:*** The cooking mode was selected and required time for it was seen on the display. Later temperature (middle) and bread size was selected (double). ***interpretation:*** Informing the users related to the duration of the selected mode may encourage them to adopt energy saving behaviour. Offering different modes for user's preferences can also contribute to the resource effectiveness. Yet the relation between modes and their consumption rate is not clear.	visibility of the process/mode, visibility of the resource consumption
turning on & baking	***observation:*** Turning on the product, the light on the display turned off. As the phases completed, the name of the stage was shown on the display (e.g. knead 1, rise 1, knead 2, etc.). ***interpretation:*** Product provides detailed information regarding the mode changes and the duration of the modes.	visibility of the process/modes
baking	***observation:*** When the bread is baked beep sound was heard and display started to blink. ***interpretation:*** Loud sound feedback urges the user to turn off the product.	visibility of the process/modes
turning off	***observation:*** The participant pushed the on/off button for 3 seconds and it was turned off. The product was unplugged. ***interpretation:*** If the user forgets to turn it off it automatically switches to the keep warm mode for an hour, which is not optional, this may lead to unnecessary energy consumption.	automation of the process, adaptability of user needs and preferences
serving	***observation:*** As removing the breads, it was observed that one of the blades was not placed properly. Thus, the dough could not be kneaded and one of the breads was baked poorly. ***interpretation:*** Since the processes are mainly automated, the participant may not check the bread throughout the whole process. As in this case, the product worked with a fifty per cent performance leading excessive resource consumption.	visibility of the process/modes automation of the process
cleaning	***observation:*** Bread pan, blades and inner circle were cleaned with a wet cloth. ***interpretation:*** The participant cleans the resistance while it is still hot, since it can be difficult to remove the stain as it dries.	ease of cleaning

Regarding the use behaviours, several issues have been remarked related to the resource consumption that can be summarised as follows:

Controls and indicators: Considering the results of the observations, it can be remarked that the controls and a wide range of indicators have been used quite effectively within this product for informing the user related to the process and achieving effective use of resources (e.g. sound feedback for plugging in, various cooking modes for user preferences, etc.). In the use phase, however, the absence of the feedback regarding the assembly of the components resulted in unnecessary resource consumption as the product performed baking for three hours with a fifty per cent performance (*visibility of the process*). Along with these, while baking the bread, the product switches to keep warm mode automatically unless the user turns the product off. In this respect, it is seen that the controls related to this phase is insufficient, since the user may not prefer to use this mode and in turn save energy.

Heat loss: The transparent sections on the cover enable the user to control the process effectively, which eliminates the need of opening the cover and reduces the heat loss.

Cleaning: While adding ingredients into the pan, some falls into the chamber unavoidably and sticks onto the resistance, which directly affects products' performance and the energy consumption. It is also difficult to clean these remains, as the chamber is undetechable. Consequently, it can be interpreted that the structural properties of the product is closely related to the resource consumption (*structural effectiveness* and *ease of cleaning*).

Table 4.18 below presents the analysis of the experience/behaviour questions for the bread maker with the aim of exploring the participant's significant experiences with the appliance.

Table 4.18: The analysis of the experience/behaviour questions for the bread maker.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "…I use the product once or twice a week…" ***interpretation:*** The appliance is used rarely compared to the other products, yet the duration of use is relatively long.	
appreciated features	***statement:*** "While baking bread, I deal with other chores, sometimes in other rooms. In such cases the beep sound is quite effective, I can hear it from almost every room." ***interpretation:*** The product reduces user involvement in the process, yet the effective feedback can encourage users to turn off the product, and in turn save energy.	visibility of the process/modes
complaints	***statement:*** "…kneading and rising phases take relatively long time compared to the whole process. Therefore, if I have time, I prefer to use the product only for baking for saving time and electricity." ***interpretation:*** Considering the duration of use, the participant believes that the product consumes energy significantly.	visibility of the resource consumption

In this phase of the interview, *the visibility of the process* through clear, and a wide range of feedbacks are mentioned as the appreciated features of the product, which can also contribute to the effective use of resources (e.g. turning off the product hearing the sound feedback, etc.). However, considering the entire process of baking bread, the user complains about the duration of baking, which is approximately three hours, and associates it directly with the intensive resource consumption, even though the information about the use of energy is unavailable (*visibility of resource consumption*).

Table 4.19: The analysis of the user insights for the bread maker.

	Responses & Interpretations	Themes
insights	***statement:*** "If the product informs me related to the energy consumption in each stage, especially the kneading and rising phases, I might prefer skipping these stages." ***interpretation:*** The visible manifestation of the resource consumption for each phase of use can contribute to the effective use of resources.	visibility of the resource consumption

In the final question, the participant's suggestions for the resource effectiveness in the use phase of the product were inquired (Table 4.19). The design intervention suggested by the participant can be explained under the notion of ***eco-feedback***. It can be interpreted that communicating the overall resource consumption in comparison with the different modes can encourage users to adopt energy saving use behaviours.

4.3.2.6. Case 6: Electric Frying Pan

Electric frying pans are utilised in households as a practical and healthy alternative to the deep fryers. Within the context of this study, the product was observed in a family household and the interview was carried out with the participation of the female household member aged 48.

The product of inquiry reduces the need of user engagement through stirring the ingredients automatically during the cooking process, and in turn enables a convenient cooking experience. It offers an on/off button, a time adjustment button, a stirring blade and a measuring spoon to adjust oil (Figure 4.7). In the research setting, the product was placed in the dishwasher. While purchasing that particular product, the participant was not concerned about the energy effectiveness.

Figure 4.7: The images from the use phase of electric frying pan.

In the next phase, the participant prepared fried potatoes and use stages were observed for gaining a comprehensive understanding of the use patterns leading to intensive resource consumption. The findings and conclusions from the observations are presented below (Table 4.20).

Table 4.20: The analysis of the use phase for the electric frying pan.

use phases	Observations & Interpretations	Themes
plugging in	***observation:*** The participant prepared the ingredients and a spoon of oil was added inside the frying pan. Later, the product was plugged in, however it did not provide any feedback. ***interpretation:*** The product does not ensure the user that it is properly plugged in. This may lead to leaving the product plugged in.	visibility of the process/modes
turning on	***observation:*** Closing the transparent cover, the time was adjusted to one minute (right button) and the product was turned on (left button) for heating the oil. ***interpretation:*** The transparent cover eases controlling the food and eliminates the need to open the cover and loosing heat.	visibility of the process/modes
warming up	***observation:*** When the oil was heated, beep sound was heard but the product kept warming up. ***interpretation:*** Despite the pre-adjusted time is reached, unlike oven the product keeps functioning till the cover is opened. The feedback may appeal to more senses to prevent additional resource consumption.	visibility of the process/modes, transformation of user behaviours/ habits
	observation: Opening the cover, the blade stopped spinning and the participant added sliced potatoes into the chamber. As closing the cover, time was adjusted to 30 minutes. ***interpretation:*** The participant adjusts the duration of cooking and the amount of ingredients based on her previous experiences.	adaptability of user needs and preferences, visibility of the scaling
	observation: The participant checked if the food was fried for once. A few minutes before the food was ready, the cover was opened to add salt. ***interpretation:*** When the cover is opened to add ingredients, the product is turned off and considerable amount of heat is lost.	adaptability of user needs and preferences

Table 4.20: The analysis of the use phase for the electric frying pan (Cont.).

warming up	***observation:*** Realizing that the food would not be fully fried at the end of the adjusted time, the user added five more minutes to the timer. ***interpretation:*** The duration of cooking in accordance with the prepared food is not provided on the product.	adaptability of user needs and preferences
turning off & unplugging	***observation:*** When the pre-adjusted time was reached, a beep sound was heard, the fryer kept on working till the user opened the cover. As emptying the pan, it was turned off and unplugged. ***interpretation:*** Since the participant is already in the kitchen while using the product, she immediately turns it off. However, the sound feedback is insufficient to notice from a distance, which may lead to intensive resource consumption as well as burning the food.	visibility of the process/modes
cleaning	***observation:*** The pan, the cover, filter and stirring blade were washed whereas the chamber was cleaned with a wet cloth. ***interpretation:*** It is difficult to clean undetachable parts (i.e. chamber).	ease of cleaning

Regarding the use phase of the product several interpretations have emerged related to the resource consumption, which can be categorised as follows:

Controls and indicators: In various cooking appliances (e.g. ovens, microwaves, etc.), when the adjusted time is reached, the product turns itself off automatically. In that sense, within this product the feedback relevant to the timer can be misleading. Informing the user with a beep sound, it continues warming up only till the cover is opened, which can result in undesired energy consumption (*transformation of user behaviours/habits* and *visibility of the process*). Additionally, the duration of cooking is adjusted intuitively based on the previous experiences, whereas the clear information considering the relation between the cooking duration and the food type can contribute to the resource effectiveness. Along with these, the participant adds ingredients without being sure about the scaling. However, the volume of the electric frying pan might be capable of cooking more food at once for energy effectiveness.

Heat loss: Transparent cover enables the user to check the food, and this eliminates the need for opening the cover and in turn prevents heat loss.

Cleaning: The material applied within the pan prevents sticking and eases cleaning, yet it is difficult to clean the undetachable parts such as the chamber.

Table 4.21: The analysis of the experience/behaviour questions for the electric frying pan.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "It mostly depends on the frequency of food consumption at home but it is used roughly twice or three times a week."	
appreciated features	***statement:*** "…all of the components are dishwasher safe, so it is quite easy to clean the product." ***interpretation:*** The material selection inside the pan eases cleaning which directly affects the water consumed throughout the cleaning process.	ease of cleaning
	statement: "I do not have to stand by the food and stir it that eases food preparation especially when I am busy." ***interpretation:*** The product offers easier frying experience through minimizing the user involvement during cooking phase. However, the automation of the process may be misleading while turning off the product.	automation of the process
complaints	***statement:*** "The frying pan does not fit into the chamber precisely. Consequently, even when the pan is not filled fully, the food falls into the chamber during stirring." ***interpretation:*** Dirt accumulated inside the chamber is difficult to clean, since the component is undetachable.	ease of cleaning, structural effectiveness

Table 4.21 above presents the analysis of the experience/behaviour questions for the electric frying pan. In this phase of the interview, dishwasher-safe components (*ease of cleaning*) and automatic stirring (*automation of the process*) were mentioned as the appreciated features of the product. However, the frying pan does not fit into the chamber precisely, and consequently ingredients may fall into the chamber while stirring. Therefore, it can be interpreted that the structural properties of the product may increase water consumed throughout the cleaning phase (*structural effectiveness* and *ease of cleaning*).

In the final question, the participant's suggestions for the development of the product

were inquired. Table 4.22 below shows the strategies relevant to effective use of resources.

Table 4.22: The analysis of the user insights for the electric frying pan.

	Responses & Interpretations	Themes
insights	***statement:*** "The product might offer cooking modes and the duration could be adjusted according to the food types such as vegetables, meats, dough, etc." ***interpretation:*** The clear relation between the food type and its approximate duration of cooking can contribute to the effective use of resources.	adaptability of user needs and preferences
	statement: "In conventional ovens when the pre-adjusted time is reached, the product turns itself off. In such a case, this one continues warming up. However, in order to prevent burning the food and using the resources effectively, the fryer might turn itself off when the timer was off." ***interpretation:*** Turning off the product automatically may save considerable energy through preventing warming up the food unnecessarily.	transformation of user behaviours/ habits, automation of the process

The design interventions indicated by the participant can be categorised as follows:

eco-steer: Auto shut off function can be embedded into the product to save energy through preventing warming up the food unnecessarily.

eco-feedback: Clarifying the duration of cooking in accordance with the ingredients can enable precise adjustments, and thus contribute to the effective use of resources.

4.3.2.7. Case 7: Steam Generator Iron

Many users prefer steam generator irons as a practical and time saver option for the ironing experience. As a consequence of the technical properties of the irons, they are responsible for excessive energy consumption compared to the other household appliances utilised in domestic everyday life. In this study, the use phases of a steam generator iron were observed in a family household, and the female household member aged 44 responded the interview questions. The particularity of this product is that the water can be stored in a separate base unit where it is heated, and then the

steam is delivered to the iron through its hose. The product offers five modes according to the properties of the fabrics, light indicators, shock steam mode, a maintenance indicator and a removable calcification stick (Figure 4.8). Throughout the observation, the product was used in the bedroom, although it is stored inside the closet when not in use. The participant prefers that particular product, since it does not require applying excessive amount of pressure to perform ironing. It can be interpreted that the resource effectiveness is not the concern of the user while selecting this product.

Figure 4.8: The images from the use phase of steam generator iron.

In the following phase, the participant ironed the piled up laundry, and the use stages were observed for a better understanding of the use behaviours around the product. Table 4.23 below presents the findings from the observation phase.

Table 4.23: The analysis of the use phase for the steam generator iron.

use phases	Observations & Interpretations	Themes
filling water	***observation:*** The participant placed the iron onto the ironing table, and the water reservoir was filled with purified water up to the maximum sign. ***interpretation:*** How to adjust the water level is not defined clearly, and this results in additional water and energy consumption, since the product warms up the entire water inside the reservoir.	visibility of the scaling, adaptability of user needs and preferences
turning on	***observation:*** The product was plugged in. Red light indicator turned on, whereas the green one started blinking. As the steam was ready, it stopped blinking and the participant started ironing. ***interpretation:*** Laundry is arranged until the steam is ready. Since it is difficult to notice the light indicator, the participant starts ironing a few minutes after the steam gets ready.	visibility of the process/modes, visibility of the temperature
ironing	***observation:*** The participant performed ironing for roughly 40-45 minutes without changing the temperature selection (maximum). Each piece of the laundry was ironed with the utilisation of shock steam to ease ironing. ***interpretation:*** Considering the intensive energy consumption while warming up or cooling down the iron, the participant prefers to accumulate laundry and iron them all together.	visibility of the resource consumption
unplugging & cooling	***observation:*** When there were only 4-5 pieces of laundry left, the user unplugged the iron and finished the remaining pieces. ***interpretation:*** Residual heat is utilised effectively, even though the appliance does not steer the user towards such behaviour.	visibility of the temperature
	observation: When unplugged all the lights turned off. The participant waited till the iron got cold. Checking the base of the iron, it was placed into the closet. ***interpretation:*** The feedback ensures that the product is unplugged. However, the temperature of the base after unplugging remains unknown.	visibility of the process/modes, visibility of the temperature
cleaning	***observation:*** Almost half the water remained in the reservoir. The user stated that she would keep the remained water and use it in the further uses. ***interpretation:*** In the case of a calcification, the product informs the user through the light indicator. The feedback directly affects the resource consumption through enabling the user to maintain the product properly and regularly, and increase its performance.	visibility of the process/modes, ease of cleaning

Table 4.23: The analysis of the use phase for the steam generator iron (Cont.).

cleaning	***observation:*** The user would clean the iron with a wet cloth but not quite frequently. ***interpretation:*** The material selection on the base eases cleaning and reduces water consumption.	ease of cleaning, structural effectiveness

The conclusions from and insights into the use phase of the product can be summarised as follows:

Controls and indicators: Water within the reservoir is heated as the iron is turned on, therefore the scaling of the water is important for the effective use of both water and electricity. However, how to adjust the water level in accordance with the amount of laundry or the duration of use remains unknown, since the product does not indicate the water level required for the process clearly. Along with this, the light indicator informing the status of the steam is difficult to notice. It should appeal to more senses to prevent warming up the product unnecessarily.

Heat loss: The participant made use of the heat in the cooling process effectively through ironing remaining pieces. However, the product does not provide any information related to the temperature of the iron after unplugging (*visibility of the temperature*).

Cleaning: The material applied on the base cleans itself automatically (*structural effectiveness* and *ease of cleaning*). Additionally, in the case of calcification, the product provides information related to the process, and enables the user to maintain the product through cleaning the calcification stick (*visibility of the process* and *ease of cleaning*). It can be interpreted that the structural properties of the product reduces water consumption in the cleaning phase. Likewise, maintaining the product properly increases the product's performance, and contributes to the effective use of resources.

Table 4.24: The analysis of the experience/behaviour questions for the steam generator iron.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "I try to pile up the laundry and do ironing once or twice a week." ***interpretation:*** The participant thinks that collecting laundry and ironing them all together save energy, since the product gets warm and cold only once.	visibility of the resource consumption
appreciated features	***statement:*** "It requires less physical power and enables easier and quicker ironing. I used to iron a shirt in approximately five minutes with my previous iron; however, with the steam iron it takes only one and a half-minutes. Thus, it also saves electricity." ***interpretation:*** The duration of ironing is associated with resource effectiveness.	visibility of the resource consumption

The findings from and insights into the experience/behaviour questions for the steam generator iron are presented above (Table 2.24). In this phase of the interview, the participant mainly mentioned the appreciated features of the product. One strategy the user has developed for resource effectiveness is piling the laundry for a period of time, and ironing them altogether, so that the product will warm up and cool down only once. The analysis of the question also indicates that the user associates the duration of ironing directly with the resource consumption, and considers that the product saves energy as ironing is performed quite faster with this product. However, quantitative data to support this argument is unavailable (*visibility of the resource consumption*).

Finally, considering the use experience, the participant's suggestions for the resource effectiveness in the use phase of the product were questioned and the findings of these are presented below (Table 4.25).

Table 4.25: The analysis of the user insights for the steam generator iron.

	Responses & Interpretations	Themes
insights	***statement:*** "…it might turn itself off when it was left on the water reservoir for a few minutes without any interaction. The product already has an auto shut off function for safety reasons but I am not sure when it is activated. " ***interpretation:*** Implementing the intended behaviour (i.e. turning off the appliance when not in use) into the product can prevent unnecessary and/or intensive resource consumption.	adaptability of user needs and preferences, automation of the process
	statement: "As unplugging the product it might inform me if it was still hot to iron a few pieces. It might also somehow notify when it is safe to store the iron." ***interpretation:*** Feedback regarding the heat remained after unplugging could enable users to utilise the energy during cooling process.	visibility of the process/modes, visibility of the temperature

The design interventions indicated by the participant can be summarised as follows:

eco-steer: Implementing auto shut-off function into the product in accordance with the user needs rather than safety precaution can contribute to the effective use of resources.

eco-feedback: The product could notify the user regarding the temperature of the product to better use the heat in the cooling process and achieve resource effectiveness.

4.3.2.8. Case 8: Air Humidifier

Air humidifiers have been used commonly as an alternative to the steam humidifiers in a wide range of contexts including hospitals, homes and offices. Along with its common usage in dry climates, the product is operated for relatively long periods, which contributes considerably to the domestic resource consumption. The product of inquiry was observed in a family household, and the interview was carried out with the participation of the female household member aged 37.

The particularity of this product is that the water is vaporised without warming up, instead it uses a high speed rotating disk to throw the water to a diffuser where it is

broken into fine droplets, and finally released to float in the air. It offers an on/off knob, a steam density adjustment knob, light indicators and a removable water reservoir with volume markings (Figure 4.9).

Figure 4.9: The images from the use phase of air humidifier.

In the use phase, the participant turned on the product before sleeping, and this phase of the use experience was observed in detail. Later, in the morning the researcher re-entered the research setting, and the observation along with the interview resumed. Since the product could be used for considerably long period of time while sleeping, this was the most reasonable method to observe the use phase of this appliance. Table 4.26 below presents the comprehensive analysis of the use stages for the product.

Table 4.26: The analysis of the use phase for the air humidifier.

use phases	Observations & Interpretations	Themes
filling water	***observation:*** The participant dislocated the water reservoir and filled it with water fully. ***interpretation:*** The relation between the duration of use and the required amount of water is not clear, thus the user fills it up to the maximum sign.	visibility of the scaling, adaptability of user needs and preferences

Table 4.26: The analysis of the use phase for the air humidifier (Cont.).

cleaning	***observation:*** Before placing the reservoir, the sponge on the base was checked. Due to the dirt accumulated there, the participant cleaned the sponge. The filter on the steam head was also controlled. ***interpretation:*** The sponge (located inside the base) and the filter (placed in the steam head) are relatively invisible, which is inconvenient for maintaining the product properly. The dust and dirt gathered within these parts directly affects the humidifier's performance and resource consumption as well.	ease of cleaning
plugging in & turning on	***observation:*** The product was plugged in, and then turned on. The light on the lower turned to red whereas the other one became green. After 1-2 minutes red light on the base turned off and humidifier started to blow steam. The participant preferred the lowest steam adjustment. ***interpretation:*** The light indicators on the product provide satisfying information related to the main process besides the plugging in phase.	visibility of the process/modes
humidifying	***observation:*** The product was used through whole night. In the morning, it was still on, however, the red light was lighted up indicating that the water level was insufficient. ***interpretation:*** It does not offer a timer, instead it turns off automatically when the water is finished that can result in intensive resource consumption.	automation of the process, adaptability of user needs and preferences, visibility of the process/modes
turning off & unplugging	***observation:*** When leaving the room in the morning, the knob on the left was rotated to zero and the humidifier was unplugged. ***interpretation:*** The absence of a feedback regarding the process may result in leaving the product plugged in.	visibility of the process/modes

Considering the use behaviours around the product several concerns have emerged as follows:

Controls and indicators: The product does not inform the user related to the humidity rate. Therefore, the participant often leaves the product on throughout the night, and it turns itself off when the water level is insufficient (*automation of the process*). Since the required water level in accordance with the intended duration of use is not clear as well, it does not enable the user to adjust or control this process

and the product is used unnecessarily for long hours (*visibility of the scaling*). Consequently, it can be interpreted that the absence of an indicator for humidity rate and/or the relation between the water level and the duration of use can extend the length of use phase, and this leads to excessive water and energy consumption. Besides, the product is relatively simple and the feedbacks related to the process are quite satisfactory except for the plugging in phase.

Cleaning: For an effective performance, the product's components (i.e. sponge on the rotated disk and the filter inside the steam head) need to be cleaned frequently. However, within the product these components are rather invisible, and this is inconvenient for maintaining the product properly (*ease of cleaning*).

Later, for an in-depth understanding of the participant's overall use experience, experience/behaviour questions were inquired. Table 4.27 below presents the insights into this phase of the study.

Table 4.27: Analysis of the experience/behaviour questions for the air humidifier.

	Responses & Interpretations	Themes
frequency of use	***statement:*** "…it is a seasonal product. We are using it almost every night when the radiators are on." ***interpretation:*** Even though it is used seasonally, the duration of use is relatively long compared to the other appliances.	
appreciated features	***statement:*** "…it operates silently which is quite satisfactory as I mostly use it while sleeping." ***interpretation:*** Silent working mode may result in leaving the product turned on unintentionally, and consequently an increase in resource consumption.	visibility of the process/modes
	statement: "While I am asleep if the water finishes, the product turns itself off. So I do not have to think whether it is working unnecessarily or any accident may happen." ***interpretation:*** The participant trusts the product, since it turns off automatically when the water is finished. However, this can also result in excessive resource consumption through extending the duration of use.	automation of the process

In this stage of the interview, the participant mainly mentions the appreciated features of the product including its silent use mode and the automatic shut-off function. Yet, *the automation of the process* implemented as a safety measure could even result in increase in resource consumption through prolonging the use phase.

In the final stage, the participant's suggestions for the effective use of resources within the air humidifier were inquired. The results of the question are presented below (Table 4.28).

Table 4.28: The analysis of the user insights for the air humidifier.

	Responses & Interpretations	Themes
insights	***statement:*** "… I often think that it works unnecessarily. It might turn itself of when the moisture in the environment is satisfactory." ***interpretation:*** Embedding the intended behaviour (i.e. measuring the level of moisture and adjusting itself accordingly) into the product could result in effective resource consumption.	automation of the process
	statement: "I might simply adjust the duration of use for using both water and energy effectively." ***interpretation:*** The product is utilised for relatively long hours, yet the timer can contribute considerably to the effective use of resources.	visibility of the process/modes, adaptability of user needs and preferences

The design interventions suggested by the participant for the effective use of resources can be categorised under the strategy of ***eco-steer***. It was indicated that the product could sense the rate of humidity, and turn itself off automatically according to the pre-set adjusted levels. Another aspect suggested by the user was related to the integration of a timer. This eco-steer strategy requires a user involvement in the process to adjust the duration of use in line with the preferences for the effective use of resources.

4.3.3 Overall Conclusions for the Product Cases

In the previous section, the comprehensive analysis of the field study involving eight product cases was presented to explore and comprehend the resource consumption patterns in the use phase of the selected products. Inquiring into the inherent properties of the products (e.g. indicators, material selection, structural characteristics, controls, etc.) as well as the use behaviours (e.g. habitual use patterns, intuitive behaviours, strategies, etc.), several considerations have been derived from the product cases that are directly related to the excessive resource consumption (Table 4.29). There are several similarities along with the differences between the product cases in terms of the content of the considerations.

Table 4.29: Overall results for the product cases.

Sustainability Considerations / Household Appliances	visibility of the process/modes	visibility of the temperature	visibility of the scaling	visibility of the resource consumption	adaptability of user needs and preferences	ease of cleaning	structural effectiveness	automation of the process	transformation of user needs/habits
Contact grill	●	●		●	●	●	●		
Turkish coffee maker	●		●						●
Mini oven	●	●		●	●	●	●	●	
Electric tea maker	●	●	●	●	●	●	●		●
Bread maker	●			●	●	●	●	●	
Electric frying pan	●		●		●	●	●	●	●
Steam generator iron	●	●	●	●	●				
Air humidifier	●		●		●	●		●	

Visibility of the process/modes: As presented in Table 4.29 above, for each product case the absence of clear, understandable and/or the perceivable manifestations of the use stages (e.g. plugging in, warming up, turning off, cleaning, etc.) are detected as one of the issues that may result in excessive resource consumption.

Visibility of the temperature: In contact grill, mini oven and steam generator cases, the ineffective use of heat throughout the cooling down process was linked to the *visibility of the temperature*. Yet, it was observed that two of the participants (i.e. steam generator iron and mini oven users) intuitively utilised the residual heat despite the lack of the incentives towards such patterns of use. Likewise, the absence of the temperature indicator in electric tea maker is considered as the reason for reheating the water repetitively and consuming significant energy as well as water.

Visibility of the scaling: This consideration has emerged within the products that utilise water in the use phase (i.e. electric tea maker, Turkish coffee maker, air humidifier) as a result of the inadequacy of the indicators for adjusting the water level, which can be considered as a significant contributor to the overall water as well as energy consumption. In the electric frying pan, similarly, while adjusting the amount of ingredients to be fried, the visibility of the scaling is linked to the ineffective use of energy, since the volume of the product can be capable of frying more food at once.

Visibility of the resource consumption: For the use phase of each product cases, communicating the use of energy in comparison to the different use stages, other appliances or the overall domestic consumption was revealed as one of the significant concerns in terms of effective use of resources. However, only a few participants emphasized the importance of that consideration during the observations and interviews (e.g. participant's concerns related to the resource consumption throughout the diverse modes in bread maker, etc.).

Adaptability of user needs and preferences: Facilitating the requirements of the users can also be suggested as a strategy to contribute to the resource effectiveness in the use phase of the products. For instance, providing temperature adjustment for the diverse preferences of the users in electric tea maker and/or communicating the adjustment of water clearly for specific needs in steam generator iron can result in

effective use of resources.

Ease of cleaning: Technology and material adopted within the products can facilitate a convenient cleaning process and reduce the consumption of resources during this stage (i.e. Turkish coffee maker, steam generator iron). In other products, on the contrary, calcification, the sticking of the food under high temperatures, and access to the product components in the cleaning phase are determined as significant contributors to resource consumption.

Structural effectiveness: Structural properties of the products were also determined as one of the issues resulting in resource consumption. For instance, heat loss due to the openings from the sides of the contact grill and the sealing around the mini oven's door appear to be significant contributors to the energy consumption. Likewise, calcification within the electric tea maker prolongs the duration of the boiling process, and consequently increases the resource consumption.

Automation of the process: It is interpreted that the automation of the process can facilitate resource effectiveness in the use phase of the appliances (e.g. accurate scaling of water in Turkish coffee maker, etc.). Yet, it can also lead to a considerable increase in resource consumption through reducing or limiting user involvement in the use stages (e.g. automatically switching to the keep warm mode in bread maker, etc.).

Transformation of user behaviours/habits: Considering the findings, resource consumption can also be derived as a consequence of transferring the habitual use behaviour associated with the old products into the new ones. Resource consumption resulting from several use patterns, for instance, filling the coffee pot intuitively with water despite the automation of the process in Turkish coffee maker and/or boiling water to keep the tea pot warm despite its separate heating coil in electric tea maker can be associated with this consideration.

In this chapter, the analysis of the user observations and interviews along with the results of and findings from the preliminary and primary research studies were presented in detail. The study provided insights into the exploration of habitual and routine use behaviours during the use phase of the selected household appliances with a particular emphasis on effective use of resources. The results were introduced

along with the sustainability considerations emerged from the research study to provide a better understanding of the reasons of excessive and/or intensive resource consumption. Considering the findings of the research (e.g. problem areas, strategies, design directions, etc.) along with their common usage in Turkish households and their considerable impacts on domestic resource consumption, two products, namely electric tea makers and contact grills, were decided to be explored in the following stages of the research in order to identify the problem areas and potential design directions further. In the following chapter, conclusions and findings from the next stages of the primary research will be revealed.

CHAPTER 5

PRIMARY RESEARCH II

This chapter presents the findings from and insights into the *primary research II*, which consists of two interrelated stages. The first stage of the research explores the use patterns around electric tea makers and contact grills with an emphasis on resource consumption through conducting user observations. The second phase of the research complements and supports the findings of the previous research stage with the aid of generative focus group sessions, which are facilitated with the actual users of the products. The results of and the conclusions from the research studies are delivered in two parts. In the first part, the findings from the user observations and the interviews for each product case and overall conclusions in relation to the design considerations are introduced. In the second part, the findings from the focus group sessions are presented in line with the mutual use phases identified by the participants, and the significant conclusions related to the effective use of resources within the use phase of the appliances are presented.

5.1. Primary Research IIA: User Observations on Electric Tea Makers and Contact Grills

5.1.1. Aim and Context of the Study

Within the context of this study, two small kitchen appliances (i.e. electric tea makers and contact grills) were explored further considering their common usage in domestic environments along with the intensive resource consumption patterns in their use phase that were initially identified through the previous phase of the study. For each product case, three user observations were conducted with diverse participants. The observations were complemented with and followed by semi-

structured interviews in order to probe into the use behaviours leading to intensive and/or extensive resource consumption. The observations were conducted in the domestic settings to be able to probe into the actual use behaviours as much as possible (Figure 5.1).

Figure 5.1: The images from the user observations and interview sessions in *primary research II.*

Once conducting the study, each interview session was transcribed verbatim and interpreted to detect the use patterns leading to excessive resource consumption. Later, the relation between the problem areas and the sustainability considerations emerged during the first stage of the primary research (i.e. user observations on various household appliances) were identified. The following section presents the findings from the research studies conducted with the electric tea maker users through cross-comparing the product cases.

5.1.2. Results of the Electric Tea Maker Cases

Within the context of the study, considering their common utilisation in everyday life along with their relatively long duration of use, three electric tea makers were explored further in domestic settings. The results of the study will be presented in two stages. The first stage presents the findings from the experience/behaviour questions (i.e. use stages, appreciated features and complaints). The second stage delivers the findings from the opinions/insights questions (i.e. strategies and suggestions for effective use of resources). Table 5.1 below introduces the participant information along with the results of the warm-up questions inquiring into the use

environment, features of the appliances, selection criteria, and frequency and duration of use for each product case.

5.1.2.1. Results of the Experience/Behaviour Questions

In the use phase of the appliances, each participant brewed tea and the researcher explored use stages in detail along with a series of follow-up questions to probe into the motivations of the use patterns. In order to better comprehend the use patterns resulting in excessive resource consumption, the findings and insights from each case will be categorised and presented in line with the use stages (e.g. filling the kettle, brewing, warming up, etc.) and evaluated further based on the contents (i.e. *temperature* and *scaling*) that are found closely related to the resource consumption. Since the feedbacks received within the use stages are essential for informing the users about the process and resource use, the nature of feedback (i.e. *visual*, *auditory* and *tactile*) for the use phases will be highlighted as well. Later, each use pattern will be linked to the related sustainability considerations emerged and developed through the previous stage of the primary research (Tables 5.2, 5.3 & 5.4).

Afterwards, the problem areas along with the sustainability considerations will be explained further for all three cases through categorising them under prominent use patterns and stages related to the excessive resource consumption within the use phase of the electric tea makers, namely *overfilling*, *overheating* and *cleaning*.

Table 5.1: Participants' information and findings from the warm-up questions for electric tea makers.

	TEA MAKER 1 (TM1)	TEA MAKER 2 (TM2)	TEA MAKER 3 (TM3)
	 		 
participant info	25 years old, female, graduate student, lives in a family household	48 years old, female, secretary, lives in a family household	32 years old, female, financial advisor, lives in a family household
product parts and features	glass tea pot, translucent kettle, power base, on/off switch, warm keeping/boiling switch, detachable tea filter, volume indicator, light indicators, a lid for using it as a kettle	kettle, glass teapot, heating station, on/off button for heating coil, boiling button, detachable tea filter and volume and light indicators	steel kettle and teapot, on/off switch, warm keeping/boiling switch, detachable tea filter and light indicators
use environment	kitchen counter; occasionally bedroom and living room	kitchen counter; occasionally living room and terrace	kitchen counter; occasionally balcony and living room
selection criteria	sensorial properties of the product (i.e. colour and material) along with the keep warm mode	relatively large capacity of the teapot compared to the previously used electric tea maker	sensorial properties of the product (i.e. colour and material)
when purchased	7-8 years	5-6 years	3 years
frequency & duration of use	once a day; approximately 1-2 hours	at least once a day; roughly one and a half hour each time	2-3 times a day; at least 2 hours

Table 5.2: Analysis for the experience/behaviour questions for TM1.

use phases	Observations/Interpretations/Complaints/Appreciated Features	Related Content: Temperature	Related Content: Scaling	Nature of Feedback: Visual	Nature of Feedback: Auditory	Nature of Feedback: Tactile	Themes
plugging in	***observation:*** The product routinely remains plugged in. ***interpretation:*** It does not communicate well related to the use phase.						visibility of the process/modes
filling the kettle	***observation:*** The kettle was filled with purified water, and the water level was adjusted in line with the number of people drinking tea. ***interpretation:*** Water is utilised responsibly, even though the product does not provide detailed indicator for an accurate adjustment. ***complaint:*** In some cases, the minimum level for boiling, which is 500 ml., does not suits well with the participant's needs, and leads to boiling water more than required.			●			visibility of the scaling (in terms of adaptability of user needs and preferences)
turning on & boiling	***observation:*** The appliance was turned on through switching the on/off button (click sound was heard and the green light on the kettle's handle lighted up). The boiling switch on the handle was pressed and water started boiling (green light turned to orange together with a click sound). ***interpretation:*** A wide range of feedbacks are embedded in the product to inform the user relevant to the process. ***appreciated feature:*** The product enables the user to observe the boiling process through the translucent material used on the kettle. Yet, it also leads to heat loss, as the outer shell is not properly insulated. ***complaint:*** The light indicator located on the handle was not implemented effectively as it was quite difficult to notice.			●	●	●	visibility of the process/modes, structural effectiveness
boiling	***observation:*** As the water was boiled, the product switched to the keep warm mode automatically (Light indicator turned to green with a click sound). ***appreciated feature:*** Sound feedbacks throughout the process are found satisfactory compared to visual ones.			●	●		automation of the process, visibility of the temperature

Table 5.2: Analysis for the experience/behaviour questions for TM1 (Cont.).

brewing	***observation:*** Turning off the product, the participant poured the water inside the teapot and later added tea pouches. ***interpretation:*** Although there is not any indicator to adjust water for brewing, the participant scales water precisely in line with the number of people.			•			visibility of the scaling (in terms of adaptability of user needs/ preferences)
filling the kettle	***observation:*** As the tea is brewed, kettle was refilled with water approximately for three people. ***interpretation:*** Likewise, the water level is adjusted precisely.			•			visibility of the scaling
re-boiling	***observation:*** The kettle was turned on and boiling mode was selected as the steam would keep the teapot warm.			•	•	•	visibility of the temperature
warming up	***observation:*** As boiling the water, it automatically switched to keep warm mode. ***interpretation:*** In some cases, the user may not need this function, yet its automatic utilisation can result in excessive resource consumption. ***complaints:*** Within the warm keeping mode, the participant feels as if considerable amount of heat is lost from the spout of the kettle.			•	•	•	automation of the process, structural effectiveness
	observation: Controlling its colour, the participant served tea approximately after 8-10 minutes. ***interpretation:*** The transparency of the teapot enables the user to follow the brewing process.			•			visibility of the process/modes
serving & turning off	***observation:*** As serving the tea, the product was turned off, considering that the heat would be sufficient for a while. Just before refilling cups, it was switched to keep warm mode, and after serving it was turned off again. This pattern was repeated several times. Approximately after 65-70 minutes, sliding the switch downwards, product along with the light indicators turned off. ***interpretation:*** Although the product does not inform the temperature of the water and/or tea, the participant develops a strategy for an effective use of water and energy.			•	•	•	visibility of the temperature, visibility of the process/modes
cleaning	***observation:*** The teapot was immediately rinsed off with water to remove the tea stains easily and the remained water was kept for further uses. ***interpretation:*** Water consumption within the cleaning process is relatively effective. Using purified water prevents calcification and enables the user to use the residual water in further uses.						ease of cleaning

Table 5.3: Analysis for the experience/behaviour questions for TM2.

use phases	Observations/Interpretations/Complaints/Appreciated Features	Related Content: Temperature	Related Content: Scaling	Nature of Feedback: Visual	Nature of Feedback: Auditory	Nature of Feedback: Tactile	Themes
plugging in	***observation:*** Placing it on the kitchen counter, the product was plugged in. ***interpretation:*** It does not inform the user related to the process accurately.						visibility of the process/modes
filling the kettle	***observation:*** Considering the relatively large volume of the teapot, the participant filled the kettle till the maximum sign with purified water. ***interpretation:*** As adjusting water, the number of people for serving is not considered which results in overfilling the kettle. ***appreciated feature:*** Purified water prevents calcification and water boils quickly.			●			visibility of the scaling (in terms of adaptability of user needs/ preferences)
turning on & boiling	***observation:*** As pushing the button on the handle, the product was turned on and indicator lighted up. ***interpretation:*** The light indicator ensures the user that the product is turned on.			●	●	●	visibility of the process/modes
boiling & warming up	***observation:*** The heating coil beneath the teapot was turned on and tea pouches were added. ***interpretation:*** Considering the conventional tea brewing process, the teapot is warmed up before the brewing process.			●	●	●	transformation of user habits
boiling	***observation:*** As the water boiled, product turned off (light indicator turned off with a click sound).			●	●		visibility of the process/modes
brewing & refilling	***observation:*** Tea was brewed approximately till the maximum capacity of the teapot. Roughly 1.4 litre of purified water was used for refilling the kettle. ***interpretation:*** The water level for brewing is adjusted in line with the teapot's capacity. ***complaint:*** If the tea is brewed till the maximum sign, tea leaves enlarges and spills over.			●			visibility of the scaling (in terms of adaptability of user needs/ preferences)

Table 5.3: Analysis for the experience/behaviour questions for TM2 (Cont.).

re-boiling	***observation:*** The kettle was turned on immediately to boil the water. ***interpretation:*** Although the product has a separate heating coil for the teapot, the participant performs a habitual behaviour that can be associated with the conventional tea brewing process and boils water unnecessarily.			•	•	•	transformation of user habits
	observation: As the tea brewed, water was re-boiled. ***interpretation:*** The product does not communicate regarding the temperature of the water, consequently water is re-boiled unnecessarily before serving.			•	•	•	visibility of the temperature
re-boiling & serving	***observation:*** Each time as serving tea, water was re-boiled to be able to offer hot tea. ***interpretation:*** Even when the temperature of the water can be convenient to drink, it is re-boiled repetitively. ***complaint:*** It requires intensive user involvement in the process.						visibility of the temperature
turning off	***observation:*** Approximately 80 minutes later, the product was turned off (light indicator on the heating station turned off).			•	•	•	visibility of the process/modes
unplugging	***observation:*** The product was unplugged. ***interpretation:*** The user stores the product in the kitchen cupboard, consequently it is kept unplugged. Yet, it does not steer the user towards such behaviour.						visibility of the process/modes
cleaning	***observation:*** Water remained in the kettle was kept for further uses. ***interpretation:*** Using purified water prevents calcification and enables the user not to waste the remained water.						ease of cleaning
	observation: As emptying the tea pouches, the teapot was rinsed off with water. ***interpretation:*** The removable filter and the material selection ease cleaning process, and in turn water is consumed effectively throughout the process.						ease of cleaning, structural effectiveness

Table 5.4: Analysis for the experience/behaviour questions for TM3.

use phases	Observations/Interpretations/Complaints/Appreciated Features	Related Content: Temperature	Related Content: Scaling	Nature of Feedback: Visual	Nature of Feedback: Auditory	Nature of Feedback: Tactile	Themes
plugging in	***observation:*** The product was plugged in as entering the research setting. ***interpretation:*** It does not inform the user related to the use stage.						visibility of the process/modes
filling the kettle	***observation:*** The kettle was filled with tap water which would be sufficient for both brewing and drinking in the following use phase. ***interpretation:*** As steel is applied on the outer shell of the kettle, the user cannot observe and adjust the water level accurately. Overfilling the kettle also results from the user's habitual behaviours, and as stated by the user, the water level is adjusted in order not to refill it.			●			visibility of the scaling, structural effectiveness
turning on & boiling	***observation:*** The product was turned on through switching on/off button (green light turned on). Later, boiling mode was selected (orange light indicator lighted up). ***interpretation:*** The product communicates visually regarding the boiling phase.			●	●	●	visibility of the process/modes
boiling & warming up	***observation:*** As the water boiled, the product automatically switched to keep warm mode (click sound was heard and green light indicator lighted up). ***interpretation:*** The light indicator can be misleading, as it is displayed as green when the product is turned on as well as keeping the water warm.			●	●		visibility of the process/modes, automation of the process, visibility of the temperature
brewing	***observation:***) Tea pouches were added and tea was brewed roughly till the three quarters of the teapot. ***interpretation:*** Water for brewing process is adjusted in line with the participant's previous experiences.						visibility of the scaling

Table 5.4: Analysis for the experience/behaviour questions for TM3 (Cont.).

warming up	***observation:*** The participant did not refill the kettle as the remaining water was sufficient. Considering the temperature of the water, keep warm mode was selected rather than re-boiling it.			●			visibility of the process/modes
brewing	***observation:*** Tea was brewed approximately 8 to 10 minutes. ***interpretation:*** It is relatively difficult to observe the brewing process as a consequence of the non-transparent material selection within the teapot. Yet, the participant determines the brewing duration based on her previous experiences.			●			visibility of the process/modes, structural effectiveness
serving & refilling	***observation:*** As serving tea, the participant refilled the kettle slightly. ***interpretation:*** The water level is adjusted intuitively.			●			visibility of the scaling, structural effectiveness
re-boiling	***observation:*** Water was boiled and then switched to keep warm mode. ***appreciated feature:*** Even when the participant turns off the product, the water does not get cold instantly as the product is insulated quite effectively.			●	●	●	visibility of the process/modes, structural effectiveness
turning off & unplugging	***observation:*** Approximately 50 minutes later, the product was turned off and left it plugged in (light indicators turned off as well). ***appreciated feature:*** Even if the participant forgets to turn off the product, which is stated to occur quite often, it turns off automatically when the water level is insufficient for safety concerns. Yet, this may also lead to intensive resource consumption.			●	●	●	visibility of the process/modes, automation of the process
cleaning	***observation:*** Removing the tea pouches, the teapot was cleaned with detergent and water. Remaining water in the kettle was kept for reutilising in the following uses. ***interpretation/complaint:*** The participant uses purified water occasionally as well as tap water, yet calcification occurs quite frequently. Consequently, the kettle is cleaned with citric acid occasionally. Yet, the use of citric acid increases water as well as the energy consumption significantly.						ease of cleaning

Considering the use phases of the electric tea makers along with the participants' particular experiences, several issues regarding the intensive and/or excessive resource consumption are highlighted and presented below.

Overfilling

Overfilling the kettle is one of the common behaviour patterns within the observations, which results in considerable resource consumption. These patterns are observed while adjusting the water level for boiling as well as brewing tea.

Within the boiling process while filling the kettles, TM1 and TM2 enable the users to see the water level whereas TM3 has a steel coated kettle without any volume indicator, which appears to be inconvenient for the accurate scaling of the water. Along with these, throughout the observations only one participant adjusts water level almost precisely, whereas the others fill the kettle with more than required water, and consume significant water and energy during boiling stage. Likewise, as brewing tea, the participants adopt diverse use behaviours. TM1 and TM3 users try to adjust the water level considering the number of people that will drink tea whereas TM2 user pours water in accordance with the teapot's capacity.

Even though in some cases the participants develop intuitive strategies for accurate scaling, volume indicators within the product cases do not communicate the water level in line with the requirements of the users (e.g. how many cups, how many people, etc.) both for boiling and brewing. This indicates that ***visibility of the scaling*** in relation to the ***adaptability of user needs and preferences*** is essential for effective use of resources.

Overheating

Overheating the water is another use pattern being apparent in the observations that may result in significant resource consumption. Firstly, none of the products provides a *temperature adjustment* for the requirements of the users, which leads to heating water up to the boiling point and consume intensive energy. Along with this, the absence of the *temperature indicator* results in re-boiling water unnecessarily. Even though the temperature of the water may be convenient for drinking, the participant using the TM2 boils the water repetitively as serving tea. TM1 and TM3, however, provide a keep warm mode, which consumes considerably less energy compared to

the boiling process. Yet, as the appliances switch to this mode automatically, users may leave it on unconsciously, and this contributes to the excessive resource consumption. Along with these, auto shut off function embedded in the TM3 for safety may lead the user to leave the product on, considering that it will eventually be turned off. As mentioned by the user, the behaviour pattern of leaving the product on occurs quite frequently and this leads to excessive energy as well as water consumption. In this regard, it can be interpreted that ***visibility of the temperature, adaptability of user needs and preferences*** along with the ***automation of the process*** are closely related to the effective use of resources.

Cleaning

Use patterns and strategies adopted in the cleaning phase are responsible for considerable water consumption. Considering the user observations, the detachable tea filter in each case offers easier cleaning process, and thus reduces the water consumption within this phase. Along with this, material applied on the teapots also affects the cleaning phase. Glass teapots (i.e. TM1 and TM2) are simply rinsed off whereas the steel one (TM3) is cleaned with detergent as it can stain instantly.

Calcification is one of the commonly mentioned concerns that may result in excessive resource consumption. In the case of calcification, water boils slower, and thus consumes more energy. Two of the participants (i.e. TM1 and TM2) use purified water to prevent calcification whereas the other boils it with citric acid frequently to remove calcification and consumes excessive water and energy. Yet, none of the users empties the kettle by the end of the use phase and wastes water, on the contrary the remained water is utilised in further usages effectively. Considering these, it can be comprehended that ***ease of cleaning*** is also crucial for resource effectiveness.

Other Insights

Informing users clearly relevant to the use phases (e.g. brewing, boiling, warming up, etc.) can steer them towards responsible use behaviours. For instance, throughout the brewing process in TM3, it is impossible to see through the teapot, and in turn brewing duration is adjusted intuitively, which leads to operating the product for longer periods of time. Apart from that, each product is used for relatively long

durations ranging from 50 to 80 minutes, which increases in the presence of guests. Yet, none of the appliances communicates regarding the use of energy and water to comprehend the resource consumption and to reduce unnecessary use of the product. Along with these, none of the products provides feedback as they are plugged in, and this can be responsible for leaving the appliances plugged in. These indicate that ***visibility of the process/modes*** and ***visibility of the resource consumption*** is essential for being informed about the use phases, and consuming resources effectively.

5.1.2.2. Results of the Opinions/Insights Questions

In this phase of the study, the participants' strategies and suggestions for effective use of resources will be presented for each case through combining the similar and/or same ones together (Tables 5.5 & 5.6).

Table 5.5: Strategies for effective use of resources in electric tea makers.

Strategies	**TM1**	As the water is extremely hot or when no one is drinking tea, the participant turns off the product to prevent unnecessary resource consumption.
		The participant tries to adjust water for boiling and brewing accurately in line with the number of people drinking tea.
	TM1 & TM2	Purified water is used throughout the process, which prevents calcification, thus the remaining water in the kettle is reused in the further uses. The lack of calcification results in effective use of water throughout the cleaning process as well.
	TM2	The product is used only when he/she drinks tea and it is turned off immediately when the process is over. However, until the delivery of the focusing paper, the participant thought that the product would not consume significant energy.
	TM3	The participant remarks his/her lack of concern related to the resource consumption, and blames the product as well for the overfilling and over-brewing patterns due to the material applied to the product. Despite the structural properties of the product, the participant tries to adjust water as accurately as possible.

Strategies: Based on the findings presented in Table 5.5, it can be interpreted that TM1 user is concerned about the resource consumption and develops strategies accordingly, whereas the TM2 and TM3 users have not considered it thoroughly until the research study. Yet, each adopts several strategies intuitively that results in

effective use of resources, namely accurate scaling of water, utilising purified water to prevent calcification and turning off the product occasionally.

Table 5.6: Suggestions for improving the electric tea makers in terms of effective use of resources.

Design Suggestions	**TM1**	Considering that the automatic switching to keep warm feature can result in intensive resource consumption through forgetting the product turned on for hours, the participant suggests auto shut off function along with the clear notifications regarding the use process.
		Detailed volume indicator for an accurate scaling is suggested such as teacup and/or mug icons rather than volume marks.
		Improved insulation to preserve the water hot for a long period of time like a thermos is considered as a contributor to resource effectiveness. In some cases, the participant cannot determine the temperature of the water and serves cold tea, which is consequently poured and wasted. In that sense, temperature indicator is proposed to make the user aware of the temperature of the water and tea before serving.
		Being able to heat water for different use scenarios (e.g. brewing herbal tea or coffee, heating water for meals, etc.) as well as to use resources effectively, precise temperature adjustment is suggested.
	TM2	After the delivery of the focusing paper, the participant realizes that resource consumption remains unnoticed within the majority of the household appliances. Being informed about it through design interventions apart from bills is proposed for increasing awareness and concern about the use of resources.
	TM3	Auto shut off function embedded as a safety precaution may result in intensive resource consumption. However, the respondent suggests automatic turn off feature when it is on for a period of time without any user interaction.
		To reduce water consumption in the cleaning phase, it is offered to apply material within the kettle that prevents calcification.
		Precise volume indicator in line with the number of people drinking tea (e.g. tea for 4 people, etc.) is suggested for an accurate scaling, and in turn effective use of water.

Design suggestions: The design strategies and insights proposed by the participants in Table 5.6 can be summarised in two categories regarding their content, namely *eco-feedback* and *eco-steer*.

eco-feedback: Considering the importance of accurate scaling of water for resource effectiveness, detailed indicators in line with the user needs (i.e. cup and/or mug

icons, number of persons) are suggested. Besides, informing the user about the temperature of the water as well as the tea is proposed to prevent serving cold tea and wasting it. Communicating the use of resources is also suggested for being aware of the overall resource consumption that the appliance is accountable for.

eco-steer: As stated by the TM1 and TM3 users, auto shut off function can prevent the user from operating the appliance for long durations, and thus reduce resource consumption considerably. Along with this, temperature adjustment is suggested to steer users to select temperature in accordance with their needs and consume resources effectively.

other insights: Improved insulation as well as the application of material that prevents calcification is proposed to contribute to the effective use of resources within the use phase of the appliances.

5.1.3. Results of the Contact Grill Cases

Within this phase of the research, realising their common usage along with the frequency of use, three contact grill cases were explored and examined in domestic environments. The findings and conclusions from the research studies will be presented in three steps in accordance with the interview guideline and concluded with the overall conclusions for the appliances with a focus on effective use of resources. Table 5.7 below introduces the participant information along with the results of the warm-up questions inquiring into the use environment, features of the appliance, selection criteria, and frequency and duration of use for each product case.

5.1.3.1. Results of the Experience/Behaviour Questions

In the use phase of the appliances, the participants were inquired to perform a task (i.e. toasting breads and preparing sandwiches) and the use phases were explored in detail through probing into them. The findings and insights from the product cases are presented in accordance with the use stages in Tables 5.8, 5.9 and 5.10. Later, use patterns and related themes (sustainability considerations) leading to intensive resource consumption will be explained further for all three cases through summarizing them under relevant categories namely *heat loss* and *cleaning*.

Table 5.7: Participants' information and findings from the warm-up questions for contact grills.

	CONTACT GRILL 1	CONTACT GRILL 2	CONTACT GRILL 3
			
participant info	29 years old, female, product designer, lives alone in a bachelor household	55 years old, female, manager, lives in a family household	28 years old, female, biologist, lives in a household with a children
product parts and features	barbeque mode, temperature adjustment (0-230°C), timer, height adjustment latch (Panini and grill modes), power and ready light indicators, detachable cast iron cooking (heating) plates, flat plate for pancake and detachable tray	barbeque mode, on/off switch, temperature adjustment knob (3 modes), detachable cooking plates and light indicators	barbeque mode, on/off switch, temperature adjustment knob (3 modes), height adjustment latch, detachable cooking plates, light indicators, hook for locking the product and a cleaning comb
use environment	kitchen counter	balcony above the microwave; occasionally kitchen	kitchen counter for utilizing; above the refrigerator for storing
selection criteria	relatively larger heating surface as well as the features of the appliance	grilling function, simplicity and brand name	relatively larger heating surface to grill more food at once compared to the participant's previous grill
when purchased	4 years	two and a half years	4 years
frequency & duration of use	at least 1-2 times a day; 5-6 minutes for toasting; approximately 30 minutes for grilling	at least 2-3 times a day; 3-4 minutes for toasting bread; at least 30 minutes for grilling meats	3-4 times a week; 6-8 minutes for toasting; 30-40 minutes for grilling meats and vegetables

Table 5.8: Analysis for the experience/behaviour questions for CG1.

use phases	Observations/Interpretations/Complaints/Appreciated Features	Related Content: Temperature	Related Content: Scaling	Nature of Feedback: Visual	Nature of Feedback: Auditory	Nature of Feedback: Tactile	Themes
cleaning	***observation:*** Before using the product, heating plates were removed and washed by hand. ***interpretation:*** Although the plates are detachable and dishwasher safe, it is quite difficult to remove the dried food remains which may lead to significant water consumption throughout the cleaning process.						ease of cleaning, structural effectiveness
plugging in & turning on	***observation:*** As attaching the plates properly, the product was plugged in (power and ready light indicator lighted up). ***interpretation:*** Even though the temperature adjustment knob also functions as an on/off button, the participant prefers to unplug the appliance to ensure that it is off for safety concerns.			●			visibility of the process/modes, visibility of the temperature
temperature adjustment	***observation:*** The participant did not change the pre-adjusted temperature which was 185°C. ***interpretation:*** Precise heat adjustment enables to select desired temperature and consequently results in effective use of energy, yet the user often prefers the same mode. ***appreciated feature:*** The precise adjustment enables the user to grill and/or warm up frozen foods homogeneously.			●			visibility of the temperature, adaptability of user needs and preferences
preparation & warming up	***observation:*** Sandwiches were prepared above the heating plates till the appliance warmed up (ready light turned off with a click sound). ***interpretation:*** Throughout the preheating process, significant heat can be lost, since the appliance remained in open position to prepare the food. ***appreciated feature:*** The product warms up quite fast.			●	●		visibility of the process/modes, visibility of the temperature

Table 5.8: Analysis for the experience/behaviour questions for CG1 (Cont.).

warming up	***observation:*** As preparing food, upper heating surface was lowered. Throughout the warming up process the participant controlled the food three times. ***interpretation:*** Considerable heat is lost as checking the food. ***complaints:*** The product offers timer, however, the participant cannot decide upon the approximate duration of use and consequently does not use the timer.						visibility of the process/modes, adaptability of user needs and preferences
unplugging & cooling down	***observation:*** Observing that the bread started to crust, the participant unplugged the product to be able to use the heat (light indicators turned off). The appliance cooled down within the next 20 minutes in open position. ***interpretation:*** The product does not communicates the temperature of the plates, yet the participant performs this energy saving behaviour habitually.			●			visibility of the temperature, visibility of the process/modes
cleaning	***observation:*** As the heating plates relatively cooled off, food remains were removed with wet towel without detaching the plates. ***interpretation:*** Cleaning the product while it is still warm eases this process. ***complaint:*** The participant concerns about the oil that has been accumulated and dried within the tray located on the backside of the appliance. Since it is difficult to notice and access this component, the participant cleans it quite rarely.						ease of cleaning, structural effectiveness

Table 5.9: Analysis for the experience/behaviour questions for CG2.

use phases	Observations/Interpretations/Complaints/Appreciated Features	Related Content: Temperature	Related Content: Scaling	Nature of Feedback: Visual	Nature of Feedback: Auditory	Nature of Feedback: Tactile	Themes
preparation	***observation:*** Breads that would be toasted was prepared and placed on the baking paper within the grill. ***interpretation:*** The participant does not preheat the product and consume energy responsibly within the preparation phase.						
plugging in	***observation:*** Product was plugged in with the absence any particular feedback. ***interpretation:*** The appliance does not inform the user related to the process properly that can result in leaving the product plugged in.						visibility of the process/modes
turning on	***observation:*** The participant pressed the on/off switch (light indicator lighted up). ***interpretation:*** It can be misleading as the on/off switch along with the lowest temperature adjustment serves the same function.			●	●	●	visibility of the process/modes, visibility of the temperature
heat adjustment	***observation:*** Highest heating mode was selected considering that it would toast the bread quicker. ***interpretation:*** The temperature adjustment is associated with the heating duration, even though it is not related. The product does not provide the user with detailed and clear information regarding the modes, which can mislead the user and result in warming up the product till undesired temperatures, and ineffective use of resources.			●	●	●	visibility of the temperature

Table 5.9: Analysis for the experience/behaviour questions for CG2 (Cont.).

warming up	***observation:*** Breads were checked three times through raising the upper heating surface. ***interpretation:*** Considerable amount of heat can be lost as checking the food. ***complaint:*** Above the appliance, approximate cooking duration in line with the recommended cooking modes are presented. Yet, this information does not quite correspond with his/her needs (e.g. crispy, raw, warm, etc.) and preferences (e.g. if the bread is stale, it will toast in a longer period of time, etc.).			●			visibility of the process/modes (in terms of adaptability of user needs and preferences)
warming up	***observation:*** As the pre-adjusted temperature is reached, the thermostat light turned off. ***interpretation:*** The light indicator may mislead the user (i.e. turned off or warming up) and result in significant resource consumption.			●	●		visibility of the process/modes, visibility of the temperature
turning off & unplugging	***observation:*** Observing the breads were toasted, the appliance was turned off, and then unplugged. ***interpretation:*** Remained heat within the cooling process is not used.			●	●	●	visibility of the process/modes, visibility of the temperature
cooling down	***observation:*** Heating plates were left in an open position in order not to burn the baking paper for using it a few more times. ***interpretation:*** Throughout the cooling process, the temperature of the plates remains unknown which leads to ineffective use of the heat.						visibility of the temperature
cleaning	***observation:*** The participant did not cleaned the product and baking paper remained in-between the plates. ***interpretation:*** The use of baking paper reduces the amount of water consumed within the cleaning process.						ease of cleaning

Table 5.10: Analysis for the experience/behaviour questions for CG3.

		Related Content		Nature of Feedback			
use phases	**Observations/Interpretations/Complaints/Appreciated Features**	Temperature	Scaling	Visual	Auditory	Tactile	**Themes**
preparation	***observation:*** Breads were prepared and placed on the plates before warming up the appliance. ***interpretation:*** The participant does not need to preheat the product.						
plugging in	***observation:*** The product was plugged in**.** ***interpretation:*** The appliance does not communicate regarding the plugging in process.						visibility of the process/modes
turning on	***observation:*** On/off switch was pressed (the light indicators above the switch and on the upper heating station lighted up). ***interpretation:*** The light indicators inform the user related to the process.			●	●	●	visibility of the process/modes, visibility of the temperature
heat adjustment	***observation:*** The participant often would prefer the middle heating mode, consequently pre-adjusted temperature was utilised without changing it. ***interpretation:*** The product does not offer precise temperature adjustment which may lead to warming up the product till the undesired and/or high temperatures, and resulting in significant resource consumption. ***appreciated feature:*** It warms up quite fast whereas cools off relatively slow compared to the participant's previous contact grill.			●	●	●	visibility of the temperature

Table 5.10: Analysis for the experience/behaviour questions for CG3 (Cont.).

warming up	***observation:*** When the pre-adjusted temperature was reached, the light indicator turned off. ***interpretation:*** The product does not communicate clearly related to the process (i.e. whether turned off or warming up) and may result in excessive resource consumption. ***complaint:*** The hook that holds the plates together was broken, thus the user considered that significant amount of heat would be lost from the opening.			●			visibility of the process/modes, visibility of the temperature, structural effectiveness
warming up	***observation:*** Controlling the breads once, the participant realised that they would be toasted roughly within the next two minutes. ***interpretation:*** The product does not inform the user regarding the duration of use or provide an indicator and/or a control to ease this process.						visibility of the process/modes
unplugging	***observation:*** To utilise the heat of the plates, the product was unplugged immediately without turning off the switch (the light indicator turned off with a click sound). ***interpretation:*** Although the product does not steer the user to such behaviour, she/he intuitively reuses the heat. Along with this, despite the absence of any indicator, the participant unplugs the appliance to ensure that it is properly turned off.			●	●		visibility of the process/modes, visibility of the temperature
cleaning	***observation:*** Baking paper and/or aluminium foil were not used considering that they would affect the food's taste. When the plates relatively cooled off, they were detached through the fitting hooks and cleaned by hand. As removing the plates, the inside of the appliance was cleaned with a wet towel. ***interpretation:*** Some ingredients (e.g. cheese, butter, etc.) may melt into the appliance through the gap between the plates, where the resistance is located. Along with this, they often dry and stick on the surface, and consequently water consumed throughout the cleaning process increases. ***appreciated feature:*** The plates can be detached and attached quite easily. ***complaint:*** As stated by the participant, removing the dirt and dust accumulated on the edges and the corners of the appliance is quite difficult. Along with this, the plates are often scratched during the cleaning stage, even though the participant cares about it.						ease of cleaning, structural effectiveness

Considering the use stages of the contact grills along with the participants' particular experiences, several concerns related to the resource consumption are highlighted and presented below.

Heat Loss

Heat loss is one of the major concerns emerged through the observations that may result in significant resource consumption. It is mainly observed while preheating the appliance, controlling the food and during cooling down process.

The participants have diverse habitual behaviours while preparing the foods to be toasted and grilled. One of them simply prepares sandwiches on the heating plates as they are warming up, whereas the others complete the preparation prior to the turning on the appliance. It can be interpreted that throughout the preheating process considerable amount of heat is lost which can be utilised effectively otherwise.

Throughout the warming up process, each participant controls the breads several times which also results in considerable heat loss. This reveals that the visibility of the food along with the process appear to be significant for resource effectiveness.

Likewise, within the cooling down process, the participants adopt different use behaviours. One participant unplugs the appliance after the breads are toasted, whereas the others turn off the product earlier to reuse the heat as effectively as possible throughout the cooling down phase. Yet, none of the appliances inform the users about the temperature of the plates to encourage them to adopt energy saving behaviour. Apart from these, one participant is also concerned about the heat released from the openings between the plates, as the hook holding the plates together is broken. These indicate that ***visibility of the process/modes***, ***visibility of the temperature*** and ***structural effectiveness*** are closely related to effective use of resources.

Cleaning

Maintaining the product properly increases its performance, and in turn positively affects the resource consumption. It can be interpreted that if the heating plates are not cleaned frequently, the participants cannot remove the dried food remains easily, and thus considerable amount of water is consumed within the cleaning process. Yet,

one participant uses baking paper to ease cleaning, and in turn consumes less water during this process. Along with the heating plates, as emphasized by the participants, corners, edges, inaccessible parts and components, where dirt and dust accumulate, are considerably difficult to clean. These concerns and observations reveal that ***ease of cleaning*** is essential for resource effectiveness.

Other Insights

Informing users clearly regarding the use phases can potentially increase their awareness and steer them to consume resources effectively. Firstly, none of the products clearly communicates the process when they are plugged in without turning on the appliance. Furthermore, the thermostat lights within the product cases are found to be misleading and confusing by each participant as these lights turn off both when the plates warm up, and the appliances are unplugged and/or turned off. Along with these, clear and precise temperature adjustment enables the users to heat the appliances in line with the desired temperatures, and use the resources effectively. Yet, only one appliance offers precise temperature adjustment whereas the others provide three modes for adjusting heat. As indicated by the participants with an exception of one, it is quite difficult to relate the selected mode with the temperature, as they are not identified clearly. These insights indicate that ***visibility of the process/modes*** and ***visibility of the temperature*** are essential for comprehending the use phases and consume resources effectively.

5.1.3.2. Results of the Opinions/Insights Questions

In this phase of the study, the strategies and suggestions of the participants for the effective use of resources in the use phase of contact grills will be presented for each case (Tables 5.11 & 5.12).

Table 5.11: Strategies for effective use of resources in contact grills.

Strategies	**CG1**	Heating plates are cleaned, as they are relatively warm for removing the remaining foods easily, and that reduces water consumption throughout this process.
	CG1 & CG3	The participants turn off the appliances just before the food is grilled/toasted, so that the heat loss is prevented considerably through utilising it effectively within the cooling down phase.
	CG2	The participant uses baking paper between the heating plates, which reduces the need of cleaning them frequently. Even though the user adopts this strategy in order not to scratch the plates while cleaning, it results in effective use of water within the cleaning process.
		Occasionally, the participant unplugs the contact grill to simply slow down the toasting process. Even though the effective use of resources is not the primary concern of the user, the residual heat is used quite effectively in such a case.

Strategies: Regarding the findings presented in Table 5.11, it can be interpreted that the participants adopt various strategies to ease the cleaning process (i.e. utilisation of baking paper) as well as to reuse the heat in the cooling down process, and these in turn result in consuming resources effectively.

Table 5.12: Suggestions for improving the electric tea makers in terms of effective use of resources.

Design Suggestions	**CG1**	Considering that it can be unnecessary to heat both of the plates while grilling/toasting food for one person, diverse temperature adjustment for each heating plate is suggested for resource effectiveness.
		Communicating the heat of the plates (e.g. how long the cooling down process takes, what the temperature of the plates is, etc.), the appliance can inform and encourage the user to use the heat within the cooling down phase.
		Edges, corners as well as the invisible parts (e.g. the backside of the plates, inside the tray, etc.) need to be cleaned easily to increase product's performance along with reducing resource consumption.

Table 5.12: Suggestions for improving the electric tea makers in terms of effective use of resources (Cont.).

Design Suggestions	**CG2**	Criticising her routine behaviour patterns throughout the use phase of the appliance (i.e. using product for a relatively long period of time in order for both toasting/grilling as well as for keeping the prepared food warm), the participant suggests clear communication of the resource consumption through the features of the product apart from being informed by the bills. As stated by the participant, realising the resource consumption within the different use phases (e.g. preheating, toasting, warming up, cooling down, etc.), one may modify his/her use behaviour accordingly.
	CG1, CG2 & CG3	Regarding the intensive water consumption in the use phase, the incorporation or use of non-stick materials (i.e. ceramic) is proposed to enable an easier cleaning experience.

Design Suggestions: Based on Table 5.12, emerging design suggestions can be summarised as follows:

eco-feedback: Considering the heat loss within the cooling down process, one participant suggests clear temperature indicator to inform and encourage users to make use of heat effectively. Along with this, communicating the use of resources for each use phase through comparison is proposed to be better aware of the consequences of the use patterns and reconsider them accordingly.

eco-steer: Providing diverse heat adjustments for upper and lower heating plates is proposed for encouraging users to warm up the appliance in line with their needs and preferences, and thus consume energy responsibly.

other insights: The application of materials that prevent sticking such as ceramic is considered for contributing resource effectiveness within the cleaning process.

5.1.4. Overall Conclusions for the Study

This study included three user observations and semi-structured interviews for each product case (i.e. electric tea maker and contact grill) with the aim of exploring use patterns leading to excessive resource consumption as well as inquiring into the motives of such behaviours. The prominent findings and conclusions from the study

can be summarised based on the considerations emerged and developed within the previous stages of the research.

Visibility of the process/modes: Within the observations, the lack of clear and comprehensible indicators related to the use stages (i.e. plugging in, warming up and/or turning off) are considered as one of the reasons of excessive resource consumption. Along with these, being able to observe the use phases (i.e. brewing and warming up) are found closely related to adopting responsible use behaviour such as preventing unnecessary use of the appliances.

Visibility of the temperature: For each product case, use patterns resulting in significant resource consumption such as repetitively boiling water, preheating the appliance, wasting the heat throughout the cooling down process are linked to the visibility of the temperature. Likewise, the lack of precise temperature adjustment is related to overheating the water and the heating plates, and in turn consuming resources excessively.

Visibility of the scaling: Throughout the observations with electric tea maker users, it is examined that even though the users are concerned about it, the lack of precise volume indicator prevents them from adjusting the water level accurately, which results in overfilling the kettle. This pattern of use consequently leads to intensive water as well as energy consumption.

Visibility of the resource consumption: Within the use phases of the product cases, none of them communicates the use of energy resulting from the intrinsic properties of the appliances along with the use patterns that otherwise can contribute significantly to the effective use of resources.

Ease of cleaning: It can be interpreted that majority of the participants do not maintain the appliances properly through cleaning them routinely. Therefore, to remove the food remains stuck on the contact grill's surface and/or calcification inside the kettle, significant amount of water is consumed within the cleaning process.

Structural effectiveness: Considering the findings, heat loss due to the insulation and the form of the kettle's spout along with the openings from the sides of the contact grill are also considered as significant factors for unnecessary resource

consumption.

Automation of the process: As stated in electric tea maker cases, the automation of the process (i.e. auto shut off as a safety precaution and switching to keep warm mode automatically) can result in limiting user engagement within the process, and may lead to unnecessary use of the product for long durations.

Transformation of user behaviours/habits: Use patterns such as heating teapot prior to brewing tea and/or boiling water even when the appliance has a separate heating coil for teapot are associated with the habitual use behaviours transferred from the conventional tea brewing process. Yet, these routine behaviours are also responsible for considerable amount of resource consumption.

Adaptability of user needs and preferences: Throughout this study, this consideration has also emerged as a sub-theme, which complements the previously mentioned considerations (i.e. *visibility of the process/modes, automation of the process* and *visibility of the scaling*). With respect to the findings derived from the study, temperature adjustments, volume indicators and modes that are inadaptable to the needs and preferences of the users are linked to the intensive and/or excessive resource consumption. In this regard, facilitating diverse needs while adjusting temperature, filling the kettle, switching the modes, warming up the plates can considerably enable effective use of resources.

In this section, the findings and conclusions of the user observations carried out in the second phase of the primary research have been presented in line with the sustainability considerations to provide a better understanding of the motives and reasons of excessive and/or intensive resource consumption. In the following section, conclusions and findings from the generative focus group sessions will be revealed.

5.2. Primary Research IIB: Focus Group Sessions

This section presents the results of the focus group sessions that have been facilitated with electric tea maker and contact grill users (Figure 5.2). The findings from the study are introduced in line with the mutual use phases identified by the participants for each product case, and later the significant conclusions related to the effective use of resources within the use phase of the appliances are revealed.

Figure 5.2: The images from the generative focus group sessions.

5.2.1. Aim and Context of the Study

Within the context of this study, two generative focus group sessions were carried out for each product case through a participatory approach. It aims towards inquiring into the user-centred as well as product-centred problem areas leading excessive resource consumption during the use phase of the products to complement and support the findings of the previous stages of the primary research. The detailed information about the participants can be seen in Table 3.6 and Table 3.7. The participants' experiences and strategies for effective use of resources were discussed further with the help of generative tools (i.e. user diary exercise and card sorting method). The guideline adopted within the sessions included three stages to probe into the participants' use experiences, their concerns about resource consumption and strategies for effective use of resources. After the sessions, participants' responses were transcribed, and missing statements were attached under the relevant use phases on the timeline (Figure 5.3). Most of the findings and insights supported the previous research phase (i.e. *primary research IIA: user observations on electric tea makers and contact grills*). The following section delivers the significant findings from the electric tea maker sessions.

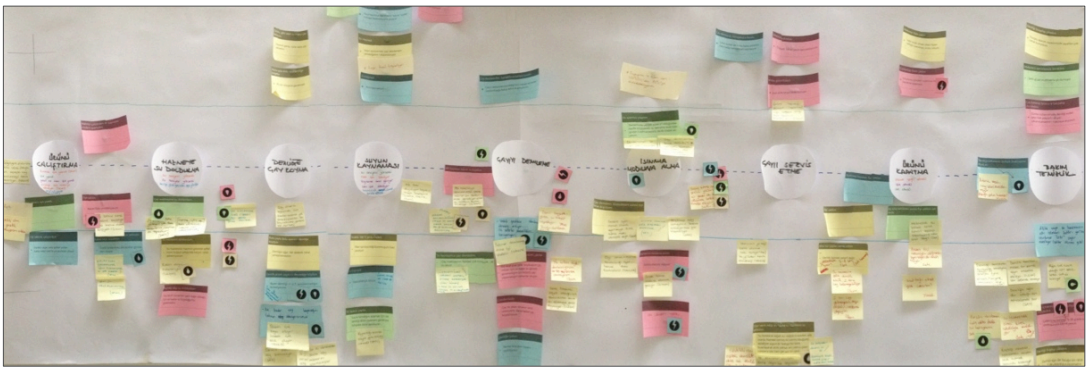

Figure 5.3: An image from the analysis process.

5.2.2. Results of the Focus Group Sessions for Electric Tea Makers

In order to have a comprehensive understanding of the problem areas considering the effective use of resources within the use phase of the electric tea makers, findings from and insights into the study will be presented in line with the use stages. Within this study, the first session was conducted with four participants whereas the other one was carried out with three. However, in order to prevent repetitions, major findings from the sessions along with the reflections will be presented together.

Filling the kettle

The participants adopt diverse patterns while filling the kettle. Some fill the kettle fully to eliminate the need of refilling it after brewing tea, whereas others adjust it considering the capacity of the teapot. Overfilling the kettle prolongs the duration of use and consumes more energy. In this regard, ***the visibility of the scaling, adaptability of the user needs and preferences*** and ***visibility of the resource consumption*** are essential to enable users to achieve accurate scaling. However, the location, comprehensibility and clarity of the volume indicators along with the applied materials for kettle and teapot (e.g. transparent and/or translucent materials such as glass, etc.) are also closely related to effective use of resources while adjusting water level. Apart from this, as stated by some of the participants, residual water from the previous usages is emptied and wasted as a consequence of the calcification within the kettle ***(structural effectiveness*** and ***ease of cleaning)***. Considering this, maintaining the appliance frequently and properly can prevent the calcification, and in turn the intensive water consumption.

Plugging in

While plugging in, the majority of the appliances do not communicate through any form of feedback regarding this process. However, in order to inform users about the use of energy, clear feedbacks (e.g. auditory, visual, etc.) relevant to the use stages are needed (***visibility of the process/modes***).

Boiling

As mentioned by several participants, the temperature adjustment enables users to select desired temperatures precisely in accordance with the needs and/or preferences and contributes to effective use of resources. Yet, it should be complemented with clear information (e.g. 80 °C for green tea, etc.) to better convey the meaning of that temperature for the users (***visibility of the temperature*** and ***adaptability of user needs and preferences)***.

Brewing

As stated by the participants, the water level for brewing tea is mostly adjusted intuitively. Consequently informing users about the required water level in accordance with the specific needs (e.g. number of persons drinking tea, etc.) and preferences (e.g. the strength of tea, etc.) of the users is essential for accurate scaling and effective use of water during the brewing process (***visibility of the scaling*** and ***adaptability of user needs and preferences***).

It can also be interpreted that being able to observe the brewing process is important to prevent excessive use of the appliance. In this regard, communicating clearly the process through providing feedback relevant to the duration of the brewing can contribute significantly to the effective resource consumption (***visibility of the process/modes***). Even though the transparency of the teapot enables the users to observe the process as well, it may also result in extra heat loss. In this regard, steel teapot with a partial transparency may potentially be a better insulator than glass.

Warming up

It can be comprehended from the responses that keep warm feature is regarded as necessary, yet the participants are often concerned about the continuous use of the appliance. With this respect, presenting resource consumption through comparing the

diverse use stages with the aid of sensorial manifestations (i.e. providing qualitative data, visualizing the consumption) can make users more aware of the energy used by the appliance, and may lead them towards effective use of resources (***visibility of the resource consumption***).

As mentioned by some of the participants, the appliance switches to keep warm mode automatically, and it is often forgotten turned on. In this sense, the automation of the process should be supported with various feedbacks related to that specific use mode to engage users within the process, and prevent intensive resource consumption (***automation of the process*** and ***visibility of the process/modes***).

Serving

While serving tea, considering that the remaining tea can be insufficient for further rounds, the participants often re-brew the tea and wait for a while for the tea to be brewed, which prolongs the duration of use considerably. In this regard, the relation between the capacity of the teapot and the kettle needs to be reconsidered and supported with clear indicators to fulfil the users' needs for resource effectiveness (***adaptability of user needs and preferences***).

Along with this, regarding the diverse use scenarios identified by the participants (e.g. transferring the appliance to the balcony without the heating station, etc.), insulation of the appliance should be considered as well for effective use resources (***structural effectiveness***).

As stated by some participants, considerable amount of water is wasted due to the form of the kettle's spout while serving tea. In this regard, the structural properties and visual features of the appliance need to be reconsidered to prevent water spill for effective use of resources (***structural effectiveness***).

Turning off & unplugging

The majority of the participants prefers to unplug the appliance to ensure that it is completely disconnected from the power source, whereas a few leave the product plugged in, since they are not aware of the fact that this phase also consumes energy. Considering this, the process needs to communicate the use of energy better to influence users towards effective use of resources (***visibility of the process/modes***).

When the water level within the kettle is insufficient, some of the appliances turn off automatically for safety. Yet, as stated by the participants, this often leads to use patterns such as leaving the product being turned on considering that it eventually turns off, and this consequently extends the duration of use considerably. With this respect, clear manifestations of the process (e.g. warning user about the duration of use and/or inadequate water level through visual and/or sound feedback, etc.) is important for engaging users in the process and encouraging them to adopt energy saving behaviours (***automation of the process, visibility of the scaling*** and ***visibility of the process/modes***).

Cleaning

It can be stated that the detachable tea basket/filter considerably eases the cleaning process. Yet, the teapot needs to be cleaned instantly as removing the tea stains require more water when they dry out (***ease of cleaning*** and ***structural effectiveness***).

Within the cleaning process, ease of access to the parts is also essential to enable convenient cleaning experience. If it is difficult to reach inside the kettle (i.e. narrow opening), the participants cannot be ensured that the detergent is removed properly, and consequently considerable amount of water is consumed or wasted (***ease of cleaning*** and ***structural effectiveness***).

Along with these, calcification is one of the commonly mentioned problems that lead to significant water as well as energy consumption. The participants adopt diverse methods to remove calcification (i.e. citric acid and descaling agent). However, the use of chemicals requires intensive water and energy consumption through re-boiling water to remove them properly. The citric acid, baking soda and vinegar appear to be natural and better alternatives, yet they still require energy and water to maintain the product parts. In that sense, informing users about the maintenance strategies and methods is closely related to the effective use of resources within the cleaning process (***ease of cleaning*** and ***structural effectiveness***).

5.2.3. Results of the Focus Group Sessions for Contact Grills

Within this study, the first focus group session was conducted with five participants and the following one carried out with three. Significant findings from the sessions along with the reflections will be presented below.

Plugging in & turning on

As mentioned by the participants, on/off switch that is available only in a few products prevents unnecessary use of the appliance through enabling control over the use stages. Yet, it needs to be supported with clear indicators regarding that process (i.e. plugging in/unplugging, turning on/turning off) for effective use of resources (***visibility of the process/modes*** and ***adaptability of user needs and preferences***).

Adjusting temperature

Precise temperature adjustment rather than pre-set cooking modes enable the participants to warm up the heating plates in line with their needs, and through preventing the overheating, it may contribute significantly to the effective use of resources. Yet, within the products that provide precise temperature adjustment, the participants adjust the temperature intuitively and often prefer the same mode. Since the duration of the cooking also changes for different types of food, it can get complicated to remember the correlation between the cooking mode and duration for each food type. Therefore, these relations need to be identified clearly (i.e. presenting approximate duration and suggested temperature/cooking mode for food types) (***adaptability of user needs and preferences*** and ***visibility of the temperature***).

Some of the participants have a presumption that through selecting higher temperatures, the appliance can warm up more quickly and accordingly consume significant energy. Yet, the quantitative data to support this concern is unavailable. In this regard, resource consumption in accordance with the cooking modes should be identified clearly to steer users towards effective use of resources (***visibility of the resource consumption***).

Preparation

Within the preparation phase, the participants adopt diverse use patterns. Some prepares the food to be grilled/toasted prior to turning on the product, and uses

energy effectively whereas the others preheat the heating plates or simply prepare the food on them while it warms up. However, as the appliance does not communicate the specific temperature of the heating plates, the duration of preheating is adjusted intuitively that can lead to overheating them, and consuming significant energy. With this respect, the ***visibility of the temperature*** along with the ***visibility of the process/modes*** is important to prevent unnecessary utilisation of the appliance.

Warming up

The heating surface/plate should be capable of grilling or toasting more food at once for effective use of energy. Yet, some grills afford the users to grill only a few pieces, consequently the appliances are used for longer periods of time and consume considerable energy (***structural effectiveness*** and ***visibility of the scaling***). Through controlling the food, significant heat can be lost, therefore, the ***visibility of the process*** is also essential for resource effectiveness.

As stated by the participants, the thermostat light that turns off as the heating plates are warmed up (except in one case, it functions in an exact opposite way) does not provide clear information related to the process. It may even mislead the user (i.e. whether the product is turned off or still warming up), and result in excessive resource consumption. In this regard, ***visibility of the process/modes*** along with the ***visibility of the temperature*** appears to be critical for energy effectiveness.

Considering the heat loss between the plates, one participant compresses the upper heating surface to reduce the heat loss along with the duration of use. Therefore, the structural properties of the appliance also need to be reconsidered to achieve resource effectiveness (***structural effectiveness***).

Along with these, the duration of use is adjusted intuitively, which often results in leaving the product on and burning the foods. With this respect, timer may enable users to adjust duration of use in line with their needs and use energy responsibly. Yet, it should also be complemented with clear feedback and indicators to be able to comprehend that, and engage in the process (***visibility of the process/modes*** and ***adaptability of user needs and preferences***).

Turning off & unplugging

Even though the appliances have an on/off switch, each participant prefers to unplug the product to ensure that the appliance is disconnected from the electricity source properly for safety concerns (***visibility of the process/modes***).

Cooling down

Considering the participants' responses, it can be interpreted that even though the plates cool down relatively slow, heat is mostly consumed ineffectively within this process. Most of the participants turn off the appliance after the food is grilled/toasted, whereas only a few mentioned to utilise the heat to preserve the food warm. Therefore, through communicating the heat of the plates (i.e. providing sensorial information about the residual heat), the users can be informed and encouraged to make use of the heat during cooling down process (***visibility of the temperature***).

Cleaning

The participants adopt diverse patterns while cleaning their appliances. Some of them prefer to clean the heating plates frequently to prevent the remains from sticking on them, whereas the others clean the heating plates quite rarely, and even hand-wash these to eliminate the scratches from the dishwasher. Furthermore, undetachable plates are cleaned through removing the remains slightly with a wet paper towel. Considering these, the properties of the material (e.g. non-stick, scratch resistant, etc.) that is adopted in the heating plates are closely related to reducing amount of water consumed during the cleaning process (***ease of cleaning*** and ***structural effectiveness***).

The use of baking paper, aluminium foil or the combination of both is the commonly mentioned methods adopted by the participants that ease the cleaning process. These patterns of use may result in significant reduction in water consumption, however, there are also health concerns regarding their usage (***ease of cleaning***).

5.2.4. Overall Conclusions from the Focus Group Sessions

This study included four focus group sessions with electric tea maker and contact

grill users in order to have a better understanding of individual's experiences and use patterns with a particular emphasis on effective use of resources. In particular, the sessions enabled to acquire a wide range of data in a relatively short period of time and supported the findings of the user observations conducted within the second phase of the primary research (e.g. overfilling the kettle, wasting heat during cooling down process in contact grills, etc.). In focus group sessions, along with the common experiences (e.g. unplugging the contact grill for safety, etc.), the participants often shared diverse use patterns (e.g. preheating the contact grill, scaling techniques, preparation phase, cleaning methods, etc.) all of which may lead to significant resource consumption. The participants' strategies for effective use of resources also showed similarities, particularly the techniques adopted during the cleaning process (i.e. use of baking paper and aluminium foil in contact grills and using citric acid in electric tea makers). The considerations emerged from the data have also been similar to the previous stages of the research. Yet, none of the participants shared an experience that was related to the *transformation of the user behaviours/habits* that was presented in the previous research stages.

In this chapter, the results of the *primary research II*, which involves two stages (i.e. user observations and generative focus group sessions), were presented in accordance with the sustainability considerations and use phases. The findings were introduced as detailed as possible to provide a comprehensive understanding of the problem areas relevant to effective use of resources within the use phase of the appliances. In the following chapter, the conclusions drawn from the research studies will be presented through revisiting the research questions.

CHAPTER 6

CONCLUSIONS

This thesis aims to explore and examine use patterns and behaviours in terms of people's involvement, interaction and awareness throughout the use phase of the electric household appliances, and revealed significant findings relevant to effective use of resources. This chapter presents the highlighted conclusions from and insights into the research studies (i.e. preliminary study and primary research studies) through revisiting the research questions. Later, the implications of this research for product design and its limitations are discussed. It concludes with the recommendations for further research considering the overall outcomes of the thesis.

6.1. Research Questions Revisited

As stated earlier, the scope of this thesis is to explore individuals' experiences with small household appliances (contact grills and electric tea makers in particular) in order to have a comprehensive understanding of the problem areas considering the effective use of resources, and incorporate these insights and knowledge for the development of sustainability considerations. Considering the aim and objectives of the study, user-centred research methods were adopted through capturing use behaviours around appliances with the aim of answering the following questions.

What are the main sustainability considerations regarding effective use of resources in the use phase of small household appliances (particularly electric makers and contact grills), and what are the implications of these for product design for sustainability?

This research including the literature review, user observations, interviews and focus group sessions has contributed to the development of the sustainability

considerations with a particular emphasis on effective use of resources. The content of these considerations have been generated through the analysis of the data from the interviews and generative focus group sessions along with the researcher's observations in the field. The definitions of and insights into the considerations can be summarised as follows:

Visibility of the process/modes: The results of the study reveal that communicating clearly about the diverse use stages and overall process can contribute significantly to the effective use of resources through increasing awareness about the use of energy (e.g. plugging in, turning on, warming up, etc.).

Visibility of the temperature: It is essential to convey the temperature of the product (e.g. heating plates, kettle, etc.) and/or the resources (i.e. water) and the significance of that temperature (e.g. 80 °C for brewing green tea, etc.) with clarity throughout the use stages that can otherwise remain unknown and lead to excessive resource consumption.

Visibility of the scaling: It can be interpreted that enabling accurate scaling of the resources (e.g. adjusting water for boiling and brewing, capacity of the heating plates, etc.) is closely related to the effective use of resources.

Adaptability of user needs and preferences: Accommodating diverse needs of users in the use phase of the products is also considered crucial to enable user engagement, and to achieve resource effectiveness (e.g. warming up the heating plates separately in contact grills, precise temperature adjustment for warming up water accurately in electric tea makers, etc.).

Structural effectiveness: Intrinsic properties of the appliances, in particular material properties and structural features of the product components (e.g. the form of the kettle's spout, opening between the heating plates, insulation of the kettle, etc.) are also found directly related to the resource consumption.

Ease of cleaning: The findings from the research studies also showed that enabling and encouraging users to maintain the product properly and regularly through providing a convenient cleaning process is essential for resource effectiveness (e.g. ease of access to the product's components, material and surface properties, etc.).

Automation of the process: Automated use stages (e.g. receiving water automatically, auto shut off, automated cleaning, etc.) can contribute to the resource effectiveness significantly. Yet, the results of the research indicate that it may also result in intensive resource consumption through reducing or limiting user involvement in the process.

Transformation of user habits: Transferring the habitual use behaviours associated with the old products intuitively into the new ones is also found to be closely related to the excessive use of resources (e.g. boiling water in order to keep the teapot warm despite its separate heating coil, etc.). Therefore, such patterns of use should be guided with design interventions for leading towards effective use of resources.

Visibility of the resource consumption: It is crucial to inform users related to the aggregate resource consumption in the use phase of the appliances that may otherwise remain unnoticed. The resource consumption can be delivered in comparison to the other use stages, other appliances or the overall domestic consumption to increase users' awareness.

The sustainability considerations emerged and developed throughout the study are not product-oriented but rather problem/suggestion-oriented. With respect to this, they are relatively comprehensive in content, and can be implemented into the development of a wide-range of household appliances and consumer electronics for effective use of resources.

What are the significant issues leading to excessive and/or intensive resource consumption in the use phase of electric tea makers and contact grills?

The user observations and the semi-structured interviews enabled the researcher to gain insights into the users' habitual use patterns or behaviours around small appliances in real-life settings with a particular emphasis on resource consumption. Likewise, the generative focus group sessions were conducted in a pre-set environment, and user diary as a generative tool was adopted to explore and comprehend user experiences in detail. The results of the research studies revealed that both inherent properties and features of the products (e.g. controls, indicators, material properties, structural characteristic, etc.) and use behaviours (e.g. habitual use patterns, intuitive behaviours, etc.) lead to the excessive resource consumption.

However, both product-centred and user-centred problem areas are closely related, and thus these cannot be isolated from one another. Considering this, the prominent problem areas regarding effective use of resources for electric tea makers and contact grills, which are emerged through the preliminary study and primary research studies, are organized in line with the use stages (e.g. turning on, warming up, cleaning, etc.), and presented in relation to the design directions suggested by the participants and the sustainability considerations (Figure 6.1). Figure 6.2 and Figure 6.3 demonstrate these relations for product cases in detail to better convey the findings of the research.

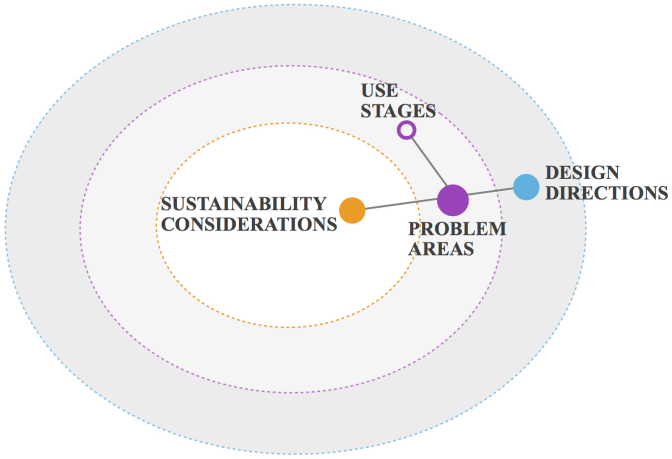

Figure 6.1: A diagram showing the way of organizing and presenting the findings of the research.

For **electric tea makers**, one of the commonly mentioned problems is the *accurate scaling of water* both for boiling and brewing. Even though a few participants developed intuitive strategies for this concern, the absence or the insufficiency of the volume indicators in line with the user needs contributes significantly to the resource consumption.

The findings from the studies also reveal that the lack of precise temperature adjustment can result in *overheating* the water, even when the lower temperatures can be adequate for the use cases. Yet another prominent issue to be considered is *calcification*, which prolongs the boiling duration, and in turn consumes significant energy. The participants adopt diverse methods and strategies to remove the lime scale accumulated on the kettle's base (i.e. citric acid, descaling agent, baking soda

and vinegar), however these methods also require significant water and energy to maintain the parts regularly. Along with this, the participants often prefer *pouring the residual water* considering that the lime accumulated within the kettle contaminates it, and this results in wasting significant amount of water. *Spout form* and the *insulation of the kettle* can also be associated with significant water and energy consumption that is related to the intrinsic properties of the appliance. Apart from these, regarding the overall tea drinking practice, the appliance is used for relatively long durations and *remains turned on* even when the practice is completed. The participants can also *leave the appliance plugged in,* since they are not aware of the fact that this phase also consumes energy.

For **contact grills**, *heat loss* is one of the major concerns that leads to considerable increase in resource consumption. The use patterns such as *pre-heating* the plates, *controlling* the food, wasting heat during *cooling down process* along with the structural properties of the appliance (i.e. *openings between the heating plates*) are considered as the main reason for the heat loss. Furthermore, the need for pre-heating is also questionable, since the plates warm up relatively fast.

The findings from the studies also reveal that it is difficult to comprehend how selected temperature/cooking mode affects the duration of cooking for various food types. Consequently, even though the appliance can provide precise temperature adjustment, the participants often prefer the same modes. This pattern of use can result in *overheating* the plates, and in turn ineffective use of energy.

In each phase of the study, the participants' responses also show that the *thermostat light*, which turns off as the plates warm up, is confusing and misleading in terms of informing the user about the use phases. In this regard, it can result in leaving the product being turned on, and consume excessive energy. *Capacity of the heating surface* is also closely related to the resource effectiveness, since it may lead to utilise the product for longer periods of time to grill/toast foods. Additionally, considerable amount of water appears to be used throughout the *cleaning phase* to remove the dried food remains. Even though the participants have developed several strategies to enable easier cleaning process (i.e. placing baking paper and/or aluminium foil between heating plates), there are significant health concerns regarding their use. *Maintaining the components* that are difficult to access also

directly affects the product's performance, and in turn resource consumption.

Along with the prominent findings explained above, the results of the user observations, interviews and generative focus group sessions for product cases also reveal that the majority of the participants are not aware of the appliances' influence on overall domestic resource consumption. Yet, a few participants perform responsible use patterns as engaging with their products, and consume water and energy effectively (e.g. accurate scaling of water, utilising the heat during cooling down process, etc.).

What are the potential solution areas and design directions to achieve effective use of resources within the use phase of products?

As overviewed in the literature review, the design of products has a profound and direct influence on individual behaviours (Lockton, 2013; Elias et al., 2009; Lilley, Lofthouse & Bhamra, 2005). With respect to this, considering the product-centred as well as the user-centred problem areas, the participants' suggestions for improving the products of inquiry in terms of effective use of resources were requested throughout the research studies. Regarding the findings of the research, several design directions for electric tea makers and contact grills are highlighted (Figure 6.2 and Figure 6.3). Some of these solution areas emphasized are already integrated into small household appliances (e.g. ceramic plates in contact grills, accurate scaling of water for brewing in automatic tea makers, etc.). Yet, others such as informing the freshness of tea and presenting the duration of cooling down process appear to be new design directions for effective use of resources.

Considering these findings, it can be interpreted that eco-feedback (e.g. communicating the use of energy on stand-by mode, etc.) and eco-steer (e.g. adjustable heating surface that affords to warm up the plates in line with the food size, etc.) design strategies are the two main design directions proposed by the participants. Eco-feedback design interventions aim to inform the users regarding the consequences of the use behaviours through providing sensorial manifestations of the resource consumption whereas eco-steer aims to guide them to intended use patterns (i.e. effective use of resources) through affordances and constraints embedded in the product (Wever et al., 2008, Lilley et al., 2005). Eco-steer design interventions, on

the other hand, can enable energy saving behaviours easier to be adopted or simply prevent undesired behaviours (i.e. use patterns that result in intensive resource consumption) automatically without users' knowledge.

The findings of the study also reveal that *comprehensibility*, *adaptability and accessibility* of the design strategies are important concerns that need to be ensured or addressed for the effective use of resources.

Comprehensibility: In order to effectively inform the user about the use phases and resource consumption, the feedback needs to be delivered clearly, so that the user can easily interpret and notice it. For instance, communicating the temperature of the heating plates in contact grills can result in utilising the residual heat effectively during the cooling down process. Likewise, through being informed about the resource consumption in comparison to use stages in electric tea makers (e.g. brewing, boiling, keeping warm, etc.) the duration of use and consequently resource consumption can be reduced significantly. Confusing and unreliable information, on the other hand, can mislead the user and cause unintended use patterns. Thermostat light in contact grills, for example, can be misinterpreted and considered as the product is turned off, while it still warms up, and consequently this may lead to intensive resource consumption.

Adaptability: Design interventions need to accommodate diverse needs and preferences of the users in order to enable user engagement for effective use of resources. In electric tea makers, for instance, clear volume indicators such as teacup and/or mug icons, strength of tea can enable the users to achieve accurate scaling in boiling and brewing stages through fulfilling their specific needs. Similarly, in contact grills enabling modular heating surface that can be selected in line with the food size (e.g. warming up a section of the heating plate for toasting a slice of bread, etc.) can contribute significantly to the effective use of resources.

Accessibility: Implementing advanced technologies in appliances (e.g. automated processes, displays, sensors, etc.) may have a positive effect on resource consumption, but accessibility of these appears to be an issue. However, simple design solutions can be as effective as these. For instance, integrating a mechanical timer into the contact grill, and supporting it with clear information about the

duration of cooking for food types can encourage energy saving behaviour through providing a relatively affordable design solution.

With respect to these findings, even though the eco-feedback and eco-steer design strategies are highlithed by the participants, a holistic strategy namely *eco-engage* have been proposed by the researcher that aims to motivate effective use of resources within the use phase of products through providing engaging and adaptable design solutions to the existing user values, needs and preferences considering the accessibility of the design interventions. The implications of this approach for product design for sustainability will be discussed further.

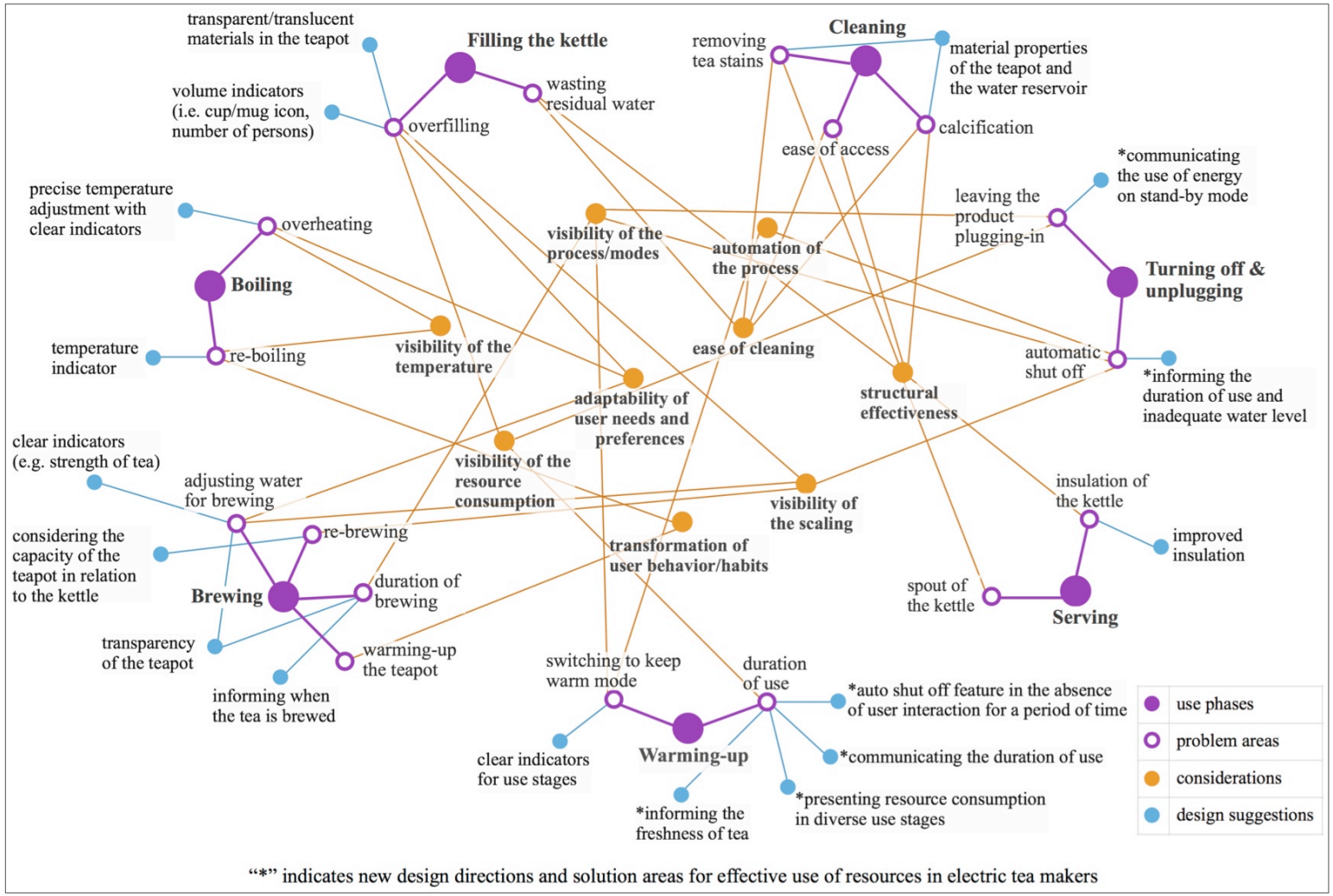

Figure 6.2: Problem areas, considerations and design directions for electric tea makers.

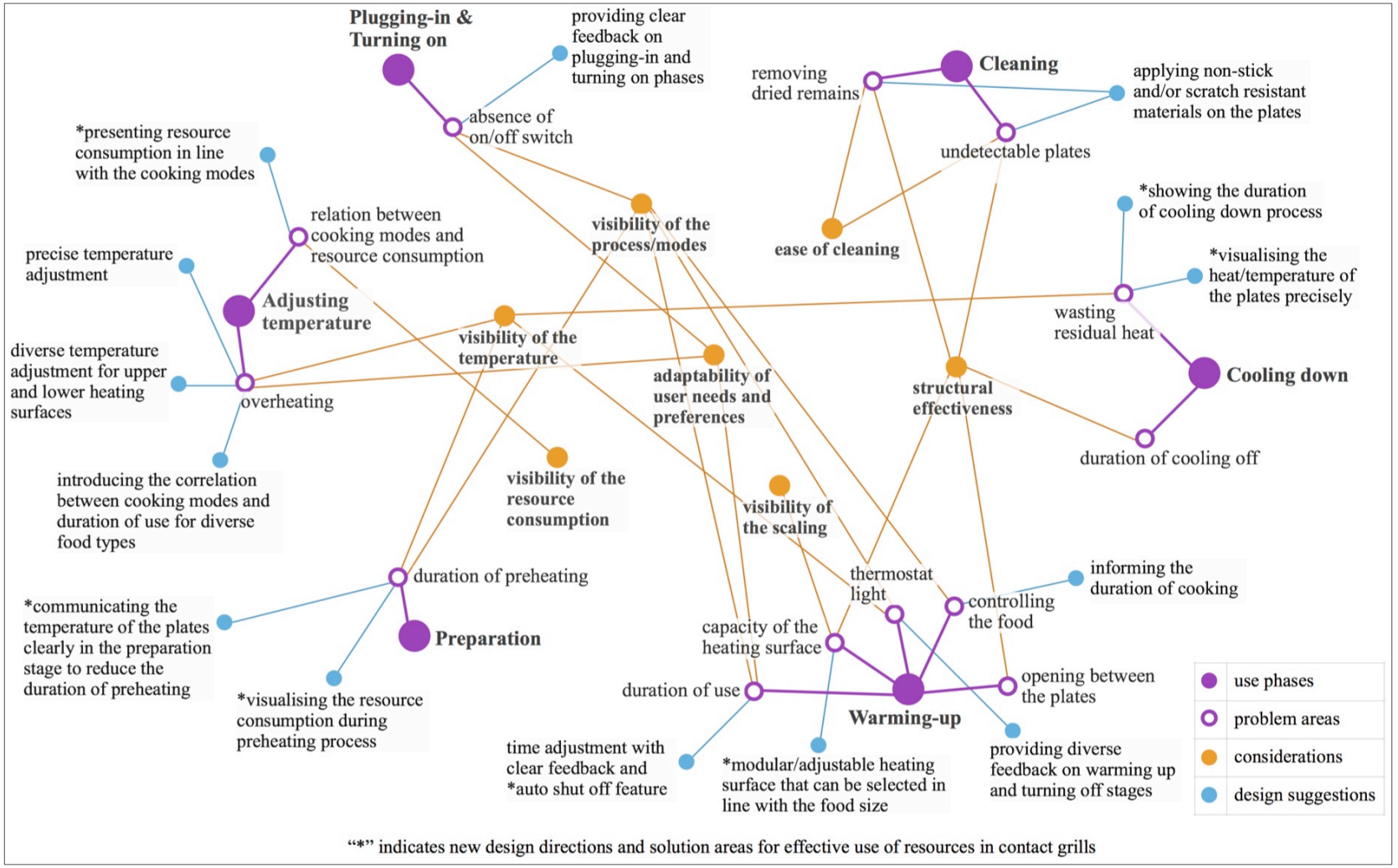

Figure 6.3: Problem areas, considerations and design directions for contact grills.

6.2. Implications of This Research for Product Design and Design Research

This thesis has provided a comprehensive review about the resource consumption in the use phase of the electric household appliances, particularly electric tea makers and contact grills, through adopting a user-centred approach. Exploring use patterns in real-life settings with actual users leads to a better understanding of how products are used as opposed to how they are said or intended to be used. The findings from the preliminary study and three interconnected primary research studies have contributed to the development of the sustainability considerations as presented previously. Also, considering the participants' design suggestions, several insights have been introduced for the successful implementation of the design directions (i.e. comprehensibility, adaptability and accessibility). These concerns have also inspired a new design strategy namely *eco-engage* that can be complemented and supported with eco-feedback and eco-steer strategies as well in order to influence energy saving use patterns within the use phase of products.

The findings and conclusions drawn from the study can be utilised in various ways. The sustainability considerations in line with proposed design strategy (i.e. eco-engage) can be adopted particularly within the household appliances sector for the development of products with an emphasis of effective use of resources. Considering the intensive domestic resource consumption, these considerations and design directions can generate valuable opportunities to reduce resource consumption during the use phase of appliances. They can also be incorporated into educational cases to enrich design students' awareness related to the environmental consequences of the use phase of the products. Since the developed considerations are not limited to the products of inquiry, they can also be adopted by a wide-range of products that are powered by electricity such as consumer electronics and domestic appliances.

6.3. Limitations of the Research

This research provides insights into the resource consumption in the use phase of appliances through qualitative and exploratory approach. Yet, supporting these insights with quantitative data (e.g. amount of energy required for boiling or keeping warm a cup of water, etc.) can further support the findings and conclusions presented

in this thesis. Consequently, availability of the studies in this area, particularly data related to the domestic resource consumption in Turkey, appears to be the limitation of this study.

In this research, it was aimed to recruit participants as diverse as possible in terms of demographic variables such as age, gender, education, geographical location, socio-economic status, etc. However, in the first two stages of the primary research, only female participants were reached based on their availability that could be considered as a limitation of the study. Along with this, all of the participants were living in the same city. Regarding the access to natural resources and other variables (e.g. population, gender, etc.), the resources (i.e. water, electricity, gas) are valued differently in diverse geographical locations, and this can influence the use patterns significantly (e.g. using electric tea maker for longer durations as the electricity is charged with relatively lower price, tea brewing techniques and traditions vary in different places, etc.). Consequently, a more comprehensive and a comparative study with a broader scope in terms of gender and geographical location may lead to diverse results in the area of focus.

Exploring individuals' use patterns and experiences is quite challenging as what people actually do often contradicts with what they say. In order to overcome this, the user observations were conducted in real-life settings, and the researcher played the role of a guest along with the observer. Despite these strategies, the presence of the researcher in the research setting might affect the use patterns and the results as well. However, considering this as a common concern of the user observations, supplementary methods and tools were employed to support the findings such as user diary in the generative sessions.

Along with these, throughout the user observations and interviews, as introducing the aim and scope of the study and carrying out the interview guideline (with an exception of opinions/insights questions), the expression 'resource consumption' was avoided in order not to bias the results as much as possible. However, the participants often digressed from the research interest, and mentioned about diverse issues related to use experience that eventually extended the duration of the interviews significantly as well as the analysis process in terms of refining the raw data and developing insights.

6.4. Recommendations for Further Research

Considering the conclusions and findings from the thesis, four areas of further research with a particular emphasis on effective use of resources can be addressed. This research has mainly revealed sustainability considerations and design directions related to the resource consumption in several small household appliances. However, it is also worth exploring use patterns around different product categories that can contribute significantly to the domestic energy consumption such as consumer electronics, major appliances (e.g. refrigerator, washing machine, etc.) and heating systems (i.e. heating appliances and thermostats). The implications of these considerations and directions can be explored further in other product categories.

Furthermore, the knowledge acquired from this research can be incorporated into a practiced-based research project based on specific product categories through reflecting on the problem areas further. The research can be conducted with an industrial collaborator in order to develop a prototype to evaluate the implications of the sustainability considerations and design directions for product design through involving users actively in the process.

The research was conducted with actual users of the products of inquiry. In future research, it would be beneficial to involve professional designers in the study in order to explore their concerns about resource consumption throughout the design process, and acquire their suggestions and insights into the development of the appliances in line with the existing manufacturing regulations and constraints related to the resource effectiveness.

Finally, even though the resource consumption within the production phase (i.e. extraction and use of raw materials) contributes significantly to the overall environmental impacts of products, this study involves resource consumption only within the use phase of the products (i.e. water and energy). In this regard, through further research the scope the research can be extended to include the resource consumption within the whole product lifespan.

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APPENDIX A

INFORMED CONSENT FORM

Turkish Version

Table A.1: Consent form prepared in Turkish for the user observations.

<table>
<tr><th colspan="2">Katılımcı İzin Formu</th></tr>
<tr><td colspan="2">Araştırma konusu: Elektrikli ev aletlerinin kullanımına yönelik kaynak tüketimi odaklı deneyim ve görüşlerin alınması

Araştırmacı: Dilruba Oğur, Yüksek lisans öğrencisi, Orta Doğu Teknik Üniversitesi

Bu araştırma Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü yüksek lisans tezi kapsamında yapılmaktadır. Araştırmanın amacı, elektrikli küçük ev aletlerinin kullanımına yönelik katılımcıların deneyim ve görüşlerinin alınmasıdır. Görüşme sırasında elde edilen veriler yalnızca bilimsel amaçlarla, tasarım sürecinde, tez araştırmalarında, bilimsel yayınlarda ve sunuşlarda kullanılacaktır. Katılımcıların kimlik bilgilerinin gizli tutulması için gerekli bütün önlemler alınacaktır. Görüşme sırasında konuşulanları daha sonra tam olarak hatırlayabilmek ve gözden geçirebilmek için görüşme sesli ve görüntülü olarak kaydedilecektir. Görüşme yaklaşık bir saat sürecektir.

Bu formu imzalayarak yapılacak araştırma konusunda size verilen bilgiyi anladığınızı ve görüşmenin yapılmasını onaylamış oluyorsunuz. Bu formu imzalamış olmanız yasal haklarınızdan vazgeçtiğiniz anlamına gelmemektedir. Görüşme sürecinin başlangıcında veya herhangi bir aşamasında açıklama yapılmasını veya bilgi verilmesini isteyebilirsiniz. İstediğiniz zaman gerekçe belirtmeksizin görüşmeyi sonlandırmayı talep edebilirsiniz. Araştırmaya katkıda bulunduğunuz için teşekkür ederim.</td></tr>
<tr><td>Görüşme tarihi</td><td>Cinsiyeti / Yaş</td></tr>
<tr><td>Toplam görüşme süresi</td><td>Mesleği</td></tr>
<tr><td>Katılımcının Adı Soyadı</td><td>Tarih/İmza</td></tr>
<tr><td>Araştırmacı: Dilruba Oğur
ODTÜ Endüstri Ürünleri Tasarımı Bölümü, Yüksek Lisans Öğrencisi
dilrubaogur@gmail.com</td><td>Tez Yöneticisi: Yrd. Doç. Dr. Çağla Doğan
ODTÜ Endüstri Ürünleri Tasarımı Bölümü
dcagla@metu.edu.tr</td></tr>
</table>

English Version

Table A.2: Consent form prepared in English for the user observations.

Informed Consent Form	
Research Subject: Exploring user experiences and insights on resource consumption within the use phase of electric household appliances **Researcher:** Dilruba Oğur, M.Sc. student, Middle East Technical University This research is conducted within the context of the master's thesis in the Department of Industrial Design at METU. The aim of this research is to understand the participants' experiences and insights related to the use phase of the small household appliances. The data received during the interview will only be used for educational purposes, design projects, thesis work and journal publications and presentations. The participants' personal information will be kept confidential. The sessions will be audio and video recorded in order to remember exactly what is told and performed. The session will take approximately one hour. Your signature on this form indicates that you have understood the information regarding the aim of this research study and agreed to participate as a research subject. Signing this form does not mean that you waive your legal rights. You may withdraw from the study at any time without any excuse. If you would like to more detail about something, please feel free to ask throughout the interview. Thank you for your participation in this research.	
Date of the session:	**Gender/Age:**
Duration of the session:	**Occupation:**
Name, Surname of the Participant	**Date/Signature**
Researcher: Dilruba Oğur METU, Faculty of Architecture, Department of Industrial Design, M.Sc. student dilrubaogur@gmail.com	**Supervisior:** Assist. Prof. Dr. Çağla Doğan METU, Faculty of Architecture, Department of Industrial Design dcagla@metu.edu.tr

APPENDIX B

PRIMARY RESEARCH IIA INTERVIEW GUIDELINE

Turkish Version

Table B.1: Interview guideline employed in *user observations on electric tea makers and contact grills* in Turkish.

1. Giriş
Benim adım Dilruba Oğur, ODTÜ Endüstri Ürünleri Tasarımı Bölümünde yüksek lisans öğrencisiyim. Görüşmeye başlamadan önce, size yüksek lisans tezi kapsamında yaptığım araştırmadan kısaca bahsetmek isterim. Araştırmanın amacı, elektrikli ev aletlerinin kullanımına yönelik katılımcıların deneyim ve görüşlerin alınmasıdır. Bu görüşme sırasında konuşulanları sadece bilimsel amaçlarla, tasarım sürecinde, tez araştırmalarında, bilimsel yayınlarda ve sunuşlarda kullanılacaktır. Kimlik bilgilerinizin gizli tutulması için gerekli bütün önlemler alınacaktır. Görüşme sırasında konuşulanları daha sonra tam olarak hatırlayabilmek ve gözden geçirebilmek için görüşme fotoğraf makinesi, video ve ses kayıt cihazı ile kaydedilecektir. Görüşmemiz tahminen 60 dk. sürecektir. Başlamadan önce sormak istediğiniz bir şey var mı?
2. Görüşmeye Dair Bilgilendirme
Görüşmemizdeki sorular üç aşamadan oluşmaktadır. Birinci aşamadaki sorular ürününüzün (elektrikli çay makinesi/elektrikli ızgara-tost makinesi) temel özelliklerini, kullanım alanını ve tercih sebeplerini anlamayı amaçlamaktadır. İkinci aşamada ürününüzü nasıl kullandığınızı gözlemleyerek kullanım deneyiminiz detaylı bir şekilde anlamayı hedefliyorum. Son aşamada, ilgilendiğim araştırma alanı ile ilgili genel bilgilerin olduğu bir odaklanma kağıdı dağıtacağım. Ardından ürününüzün kullanım aşamalarını ve deneyiminizi bu bilgiler doğrultusunda tekrar gözden geçirerek konu ile ilişkili stratejilerinizden bahsetmenizi ve ürünün geliştirilmesi için önerilerinizi belirtmenizi isteyeceğim.

Table B.1: Interview guideline employed *in user observations on electric tea makers and contact grills* in Turkish (Cont.).

3. Görüşme Soruları ve Amaçları	
ısınma soruları	**S1:** Ürününüzün kullanım alanını kısaca tarif edebilir misiniz (ör: kullanım alanının özellikleri, ürünün çevresindeki diğer ürünlerle ilişkilendirilmesi, depolama, vb.)? Eğer ürünü mutfak dışında kullanıyorsanız, bu farklı kullanım alanlarından bahsedebilir misinz (salon, balkon, komşularla bahçede toplanıldığında,vb.)?
	amaç: farklı kullanım alanlarının ürünün performansı ve dolayısıyla kaynak tüketimi ile olan ilişkisinin gözlemlenmesi (ortamın ısısı, toz, vb.)
	S2: Ürünün özellikleri nelerdir (fiziksel özellikleri, teknik özellkileri, controller, paneller, ek özellikler, aksesuarlar, vb.)?
	amaç: ürünün fiziksel ve teknik özelliklerinin öğrenilmesi, ürün parçalarının ve fonksiyonlarının tanınması
	S3: Ürünü ne kadar zamandır kullanıyorsunuz? Ürünü hangi durumlarda ve ne sıklıkta kullanıyorsunuz ve ortalama ne kadar süre çalıştırıyorsunuz?
	amaç: katılımcının deneyimi, ürünün kullanım sıklığı, kullanım süresi ve kullanım durumları hakkında bilgi sahibi olunması ve bu verinin kaynak tüketimi ile ilişkilendirilmesi
	S4: Daha önce kullandığınız başka bir ürün (çay makinesi ya da ızgara) var mıydı? Eğer varsa, ürünü hangi nedenlerle değiştirdiniz? Bu ürünü tercih etmenizdeki temel ölçütler nelerdir (enerji verimliliği, ürünün özellikleri, vb.)?
	amaç: kullanıcının ürünü tercih etmesinde enerji verimliliğinin rolünün incelenmesi
deneyim/davranış soruları	**S5:** Ürünü nasıl kullandığınızı ürününüz ile bir iş (çay demlemek, tost yapmak, ekmek kızartmak, vb.) yaparak anlatabilir misiniz?
	Ürünün kullanım aşamalarının (hazırlık, kaynatma, ısıtma, temizlik, vb.) gözlemlenmesi ve bunların kaynak tüketimi ile ilişkilendirilmesi Yoğun kaynak tüketimine yol açan, alışkanlık haline gelmiş kullanıcı davranışların saptanması Tasarım detaylarının (göstergeler, ışıklar, kontroller, malzeme, vb.) kaynak tüketimi ile ilgili nasıl bilgi sağladığının incelenmesi Kaynak tüketimine yönelik geri bildirimin nasıl sağlandığını, ne kadar süreyle ve ne sıklıkta verildiğini gözlemlenmesi
	S6: Ürünle ilgili herhangi bir sorununuz var mı? Varsa, kısaca bahsebilir misiniz? Ürünün memnun kaldığınız özellikleri nelerdir?
	amaç: kaynak tüketimine yönelik potansiyel problem alanlarının belirlenmesi

Table B.1: Interview guideline employed in *user observations on electric tea makers and contact grills* in Turkish (Cont.).

ODAKLANMA KAĞIDININ DAĞITILMASI	
amaç: katılımcının, kullanıcı davranışları ve kaynak tüketimi ilişkisi ile ilgili bilinçlendirilmesi, kullandığı ürünü kaynak tüketimini odaklı yeniden değerlendirmeye teşvik edilmesi	
görüşler	**S7:** Ürünün farklı kullanım aşamalarında (kaynatma, ısıtma, temizleme, vb.), kaynakların (su ve enerji) verimli kullanılması için geliştirdiğiniz yöntemler ve/veya uyguladığınız stratejiler var mı? Varsa, bunlardan kısaca bahseder misiniz?
	amaç: kullanımın farklı aşamalarındaki kaynak verimli kullanımı odaklı geliştirilen yöntem ve stratejilerin belirlenmesi
	S8: Kaynakların verimli kullanılması amacıyla ürünün geliştirilebilmesi için önerileriniz var mı? Varsa, bunlardan kısaca bahseder misiniz?
	amaç: belirlenen problem alanlarınına ilişkin kaynakların verimli kullanımına yönelik çözüm önerilerinin alınması

English Version

Table B.2: Interview guideline employed in *user observations on electric tea makers and contact grills* in English.

1. Introduction	
I am Dilruba Oğur, a M.Sc. student at the Department of Industrial Design, METU. Prior to the study, I would like to give you information about the aim and scope of the research I conduct within the context of my master's thesis. This study aims to understand the participants' experiences and insights related to the use phase of the electric household appliances. The data received during the interview will only be used for educational purposes, design projects, thesis work and journal publications and presentations. Your personal information will be kept confidential. The sessions will be audio and video recorded in order to remember exactly what is told throughout the sessions. The session will take approximately one hour. Do you have any questions before starting the session?	
2. Information about the interview	
Research questions comprises of three stages. The first stage aims to comprehend the main features, use environment and selection criteria of your product (i.e. electric tea maker, contact grill). In the second stage, through observing how you use your product, it is aimed to understand your use experience in detail. In the final stage, I will distribute a focusing paper that involves several facts related to the research area. Afterwards, considering the use stages and your experience in line with this knowledge, I would like you to talk about your strategies related to the area of research and suggestions for the development of the product.	
3. Interview Questions and their Intended aim	
Warm-up questions	**Q1.** How would you describe the use environment for the product (e.g. the feature of the use environment, spatial arrangement of the product in relation to other products, storing, etc.)? Also, if applicable, tell me more about atypical use environments and occasions.
	aim: to explore the relationship between the use environment and product performance, and its impact on the resource consumption (e.g. dust, heat, etc.)
	Q2. What are the characteristics and features of the product (e.g. physical characteristics, technical features, controls, displays, additional functions and accessories, etc.)?

Table B.2: Interview guideline employed in *user observations on electric tea makers and contact grills* in English (Cont.).

	aim: to acknowledge the physical and technical features of the product, exploring product parts and their function
	Q3. How long have you been using this product? How frequently do you use it (frequency, occasions of use, duration of use)?
	aim: to explore the expertise of the user, frequency, duration and occasions of product use and relating this data with resource consumption
	Q4. Did you have an electric tea maker/contact grill prior to this one? If so, what were the reasons for changing the previous one? What were your selection criteria for choosing that particular product (e.g. energy efficiency, features, etc.)?
	aim: to explore the impact of energy efficiency while selecting the product
Experience/behaviour questions	**Q5.** Could you describe your use experience through performing a task with your product (e.g. brewing a tea, toasting/grilling a bread, etc.)?
	aim: to observe the use experience and the use phases of the product (preparation, boiling, warming up, cleaning, etc.) and relating them with resource consumption to observe habitual and routine use behaviours leading to excessive resource consumption to observe how design details (displays, lights, controls, materials) provide information to the user related to resource consumption to observe the nature (e.g. visual, auditory, tactile, etc.), frequency and duration of the feedback
	Q6. What are your complaints or appreciated features related to the product (e.g. accidents, feedbacks, etc.)?
	aim: to inquire into the potential problem areas related to resource consumption
DELIVERY OF THE FOCUSING PAPER (FACT SHEET)	
aim: informing participants about the relation between the use behaviour and resource consumption and encourage them to re-evaluate their products with a focus on resource consumption.	

Table B.2: Interview guideline employed in *user observations on electric tea makers and contact grills* in English (Cont.).

Opinions & insights	**Q7.** What are the methods/strategies you have developed to reduce resource consumption (i.e. water and electricity) throughout the use phase of your product (e.g. boiling, brewing, keeping warm, cleaning, etc.)?
	aim: to explore participants' methods and strategies developed for the effective use of resources within the diverse use stages
	Q8. Do you have any suggestions for improving the product of inquiry in terms of effective use of resources?
	aim: acquiring participants' suggestions related to the identified problem areas on resource effectiveness

APPENDIX C

FOCUSING PAPER

Turkish Version

Figure C.1: Focusing paper delivered during *user observations on electric tea makers and contact grills* in Turkish.

English Version

Figure C.2: Focusing paper delivered during *user observations on electric tea makers and contact grills* in English.

APPENDIX D

FOCUS GROUP SESSIONS GUIDELINE

Turkish Version

Table D.1: Guideline adopted in *focus group sessions* in Turkish.

GİRİŞ	Odak grup çalışmasını başlamadan önce, size yaptığımız araştırmadan kısaca bahsetmek isterim. Biz ODTÜ Endüstri Ürünleri Tasarımı Bölümünde tam zamanlı çalışmakta olan eğitim ve araştırma elemanlarıyız. Benim adım _____, arkadaşlarımın adları _____ ve _____. Bu araştırmayı bir TÜBİTAK projesi kapsamında, elektrikli ev aletleri sektöründe ürün deneyimi açısından, sizin görüşlerinizi almak için gerçekleştiriyoruz. Bu çalışmada konuşulanları sadece bilimsel amaçlarla kullanacağız ve kimlik bilgilerinizi saklı tutacağız. Konuştuklarımızı daha sonra tam olarak hatırlayabilmemiz için, görüşme sırasında ses, video ve fotoğraf kaydı alacağız. Görüşmemiz tahminen _____ dk. sürecektir. Başlamadan önce sormak istediğiniz bir şey var mı?
AŞAMA I	**Deneyimlerin gruplandırılması** Küçük kağıtlar üzerine yazılan ve size verilen önceden belirttiğiniz olumlu ve olumsuz deneyimlerinizi, zaman çizelgesi üzerinde belirtilen ilgili aşamalara göre konumlandırınız. Birbirinizin olumlu olumsuz deneyimlerini lütfen okuyunuz. Aşamalarla ilgili yeni olumlu olumsuz deneyimlerinizi verilen boş kağıtlara yazıp çizelgeye ekleyebilirsiniz. Yakın olanları birbiriyle ilişkilendirerek gruplandırınız.
AŞAMA II	**Kaynakların verimli kullanımına yönelik görüş ve önerilerin alınması** Hangi aşamalarda ürünün gereksiz/fazla su tükettiğini düşünüyorsunuz? Neden? Verilen etiketleri zaman çizelgesi üzerinde konumlandırınız. Hangi aşamalarda ürünün gereksiz/fazla elektrik tükettiğini düşünüyorsunuz? Neden? Verilen etiketleri zaman çizelgesi üzerinde konumlandırınız. Elektrik ve su tüketimini azaltmaya yönelik geliştirdiğiniz yöntemler veya çözümler var mı? Sizce bu üründe geri bildirimin sorunlu olduğu aşamalar var mı? Neden? Suyun ölçülendirilmesine yönelik sorunlar var mı? Neden?

Table D.1: Guideline adopted in *focus group sessions* in Turkish (Cont.).

KATILIMCI İZİN FORMU	Bu araştırma, TÜBİTAK tarafından desteklenen "_____" isimli proje kapsamında, Ortadoğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü tarafından gerçekleştirilmektedir. Bu araştırmanın amacı, elektrikli ev aletleri sektöründe ürün deneyimi açısından, kullanıcı görüşlerini almaktır. Bu görüşme sırasında konuşulanlar sadece bilimsel amaçlarla kullanılacaktır ve kimlik ve kurum bilgileriniz paylaşılmayacaktır. Konuşulan konuların kaybolmaması ve sonrasında bir bütün olarak değerlendirilebilmesi için görüşme sırasında ses, video ve fotoğraf kaydı alınacaktır. Araştırma sürecinde katılımcı olarak söylediğiniz her şey, bilimsel ve eğitim amaçlı sunuş ve yayınlarda kullanılacaktır. Katılımcılardan aşağıdaki formu doldurmalarını istemekteyiz. Bu formun amacı, yaptığımız görüşmeleri değerlendirirken bilgiyi sınıflandırmamıza ve görüşme sonuçlarında çıkabilecek herhangi bir sorunda sizinle iletişime geçmemize yardımcı olmaktır. Bu bilgiler kesinlikle paylaşılmayacaktır.	
	Görüşmeyi yapan araştırmacılar	
	Görüşme tarihi	
	Görüşme yeri	
	Toplam görüşme süresi	
	Katılımcının adı, soyadı	
	Yaşı	
	Mesleği ve işi	
	Bu formu imzalayarak yapılacak görüşme konusunda size verilen bilgiyi anladığınızı belirtmiş oluyorsunuz. Formu imzalamış olmanız yasal haklarınızdan vazgeçtiğiniz anlamına gelmemektedir; ayrıca araştırmacıların, ilgili kişi ve kurumların yasal ve mesleki sorumlulukları devam etmektedir. Bu araştırmaya katılım, gönüllülük esasına dayanır ve katılımcılar açısından herhangi bir risk taşımamaktadır. Araştırmaya katkıda bulunduğunuz için teşekkür ederiz.	
	Araştırmacının: Adı, Soyadı: İmza: Tarih:	**Katılımcının:** Adı, Soyadı: İmza: Tarih:

English Version

Table D.2: Guideline adopted in *focus group sessions* in English.

INTRODUCTION	Prior to the focus group session, I would like to give you information about the research we conduct. We are full-time researchers in the Department of Industrial Design at METU. My name is _____, and my friends are _____ and _____. This research is carried out within the context of a TÜBİTAK project and it aims to inquire into your insights in terms of user experience in electric household appliances. The data received during this study will only be used for educational purposes and your personal information will be kept confidential. The sessions will be audio and video recorded in order to remember exactly what is told during the sessions. The study will take approximately_____ minutes. Do you have any questions before starting the session?
PHASE I	**Grouping the Experience** Please attach your positive and negative experiences, which are transcribed on the small cards and given to you in advance, under the relevant use stages identified on the timeline Please read each other's positive and negative experiences You may write down and add new positive and negative experiences related to the use phases on the empty cards provided. Please group the similar experiences through defining the relation between them,
PHASE II	**Acquiring the insights and suggestions on effective use of resources** Which use stage do you think the product consumes unnecessary/excessive water? Please attach the given water icons under the relevant stage on the timeline and explain why. Which use stage do you think the product consumes unnecessary/excessive energy? Please attach the given energy icons under the relevant stage on the timeline and explain why. Do you have any methods and/or strategies developed to reduce electricity and water consumption? Are there any problems related to the feedback received throughout the use stages of the product? Why? Are there any problems regarding scaling of the water? Why?

Table D.2: Guideline adopted in *focus group sessions* in English (Cont.).

INFORMED CONSENT FORM	This study is carried out by the METU Department of Industrial Design within the context of a project "_____" funded by TÜBİTAK. The purpose of this research is to explore the participants' insights related to the product experience in the electric household appliances sector. The data received during the interview will only be used for academic purposes and your personal and institutional information will be kept confidential. The sessions will be photo, audio and video recorded in order to prevent data loss and to be able to evaluate the recordings as a whole. Your responses throughout the session will be used for presentations and publications with scientific and educational purposes. We would like you to fill in the form given below. The purpose of this form is to help us to categorize the data while analysing the sessions and reach you if any problem arises regarding the research findings. This information will not be shared with anyone.	
	Researchers facilitating the session	
	Date of the session	
	Place of the session	
	Duration of the session	
	Name, surname of the session	
	Age	
	Occupation	
	Your signature on this form indicates that you have understood the information regarding the aim of this study. Signing this form does not mean that you waive your legal rights nor release the researchers, sponsors or involved institutions from their legal and professional responsibilities. Your participation is voluntary and it does not have any risk for the participant. Thank you for your participation in this study.	
	Researcher: Name, Surname: Signature: Date:	**Participant:** Name, Surname: Signature: Date: