Faculdade de Design, Tecnologia e Comunicação
Universidade Europeia

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SEVGİ GAYE AYANOĞLU

THE DESIGN OF FASHIONABLE WEARABLES TO PROMOTE SUSTAINABLE BEHAVIOURS IN SMART CITIES

Tese apresentada ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Design, realizada sob a orientação científica da Doutora Maria Emília Capucho Duarte, professora associada da Universidade Europeia e da Doutora Maria Madalena Rocha Pereira, professora auxiliar da Universidade da Beira Interior.

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PALAVRAS-CHAVE Vestivel na Moda; Comportamento Sustentável; Cidade Inteligente; Design Centrado no Ser Humano; Design para Mudança de Comportamento

RESUMO

A falta de sustentabilidade que ameaça o nosso futuro necessita de atenção urgente, exigindo uma abordagem holística. Contudo, ações explicitamente destinadas a mudar o comportamento humano não são muito comuns quando, paradoxalmente, grande parte do impacto ambiental está associado ao comportamento das pessoas na sua vida quotidiana. Muitas ações insustentáveis estão atualmente a ter lugar nas cidades, causando impactos negativos. As cidades oferecem respostas a muitas necessidades da vida, o que motiva as pessoas a procurarem estes espaços, causando uma concentração populacional. Esta procura do meio urbano decorre da expectativa de ter melhor qualidade de vida.

A mobilidade urbana, por seu lado, que pode ser vista como um facilitador do acesso a múltiplas componentes da vida quotidiana, incluindo empregos, educação, cuidados de saúde e muitos outros pode, também, gerar congestionamentos, poluição, um acrescido consumo energético e aumento de stress, afetando diretamente a qualidade de vida das pessoas. Neste contexto, as escolhas pessoais quanto à mobilidade têm um impacto substancial na vida quotidiana. Contudo, dado que as cidades estão a tornar-se "inteligentes", graças à aplicação de tecnologias emergentes de identificação, deteção e comunicação, nomeadamente com recurso à tecnologia da Internet das Coisas (IoT – Internet of Things), abrem-se novas possibilidade para alteração dos comportamentos da vida quotidiana, com impacto na sustentabilidade. Este desenvolvimento tecnológico tem vindo a ser explorado em múltiplas áreas, incluindo energia / instalações, transportes, cuidados de saúde, segurança, monitorização doméstica, entre outras, sendo reconhecido como uma tendência com forte crescimento a curto prazo. Neste contexto, este estudo pretendeu explorar a possibilidade de promover comportamentos de mobilidade considerados mais sustentáveis através do design de artigos de moda que possam funcionar como elementos ativos no sistema de uma cidade "inteligente". A possibilidade de combinação de funcionalidade e sedução, o poder motivador da moda, combinado com tecnologia avançada e sensores, foi entendido como tendo fortes argumentos para ser bem-sucedido na

modificação do comportamento. Como ocorre com muitos outros produtos, os produtos da moda são pensados para responder às expetativas, necessidades e limitações das pessoas, onde convivem aspetos funcionais, ergonómicos, afetivos e emocionais, fortemente focados na experiência e no envolvimento, mas com assumido enfoque na componente estética, estilo, estatuto e formação de identidade. Estes são parte essencial da mudança de comportamento. As tecnologias digitais embutidas nos têxteis oferecem oportunidades significativas de alargamento das funcionalidades dos produtos de moda, incluindo a comunicação, transformação da informação do nosso corpo em dados, conduzindo energia, brilhando, crescendo e muitos outros. Alguns bons exemplos deste tipo podem já ser encontrados na promoção da segurança humana, saúde/ bem-estar, treino militar e entretenimento. Nesta investigação, o termo "fashionable wearables" é adotado para enfatizar a combinação de moda e tecnologia.

Importa ressalvar que o objetivo deste estudo não foi trabalhar questões de moda sustentável, que é outra questão vital, mas que fica fora do recorte deste trabalho. O principal objetivo foi explorar como e em que medida as soluções de "fashionable wearables" podem promover comportamentos mais sustentáveis em cidades inteligentes. As escolhas de mobilidade foram selecionadas como comportamentos-alvo que se pretendem alterar. Para o conseguir, foi utilizada uma metodologia mista, de acordo com a abordagem do Design Centrado no Humano. A abordagem do Design para a Mudança de Comportamento foi utilizada para fornecer soluções a um nível do design conceptual. Este estudo de doutoramento foi pensado como uma investigação pelo design, no qual o design conceptual desempenhou um papel formativo na geração do conhecimento. Utilizámos dados qualitativos e quantitativos para explorar o contexto, identificar os tópicos, gerar ideias e soluções e verificar conceitos para cumprir objetivos. A metodologia proposta foi dividida em cinco fases: (1) Compreender, (2) Descobrir, (3) Design Conceptual, (4) Protótipo, e (5) Avaliação. Na primeira fase, aprofundámos os conhecimentos teóricos sobre temas de investigação e fizemos revisões de literatura. Compreendemos a noção atual de sustentabilidade e do comportamento sustentável com entrevistas a peritos e métodos de mapeamento de conceitos. Identificámos comportamentos sustentáveis e exemplificámo-los

considerando domínios da vida quotidiana e tipos de comportamento. Determinámos os comportamentos que têm um impacto mais negativo na vida quotidiana. No final, decidimos concentrar-nos nos comportamentos de mobilidade.

Na segunda fase, explorámos os obstáculos à adoção e/ou manutenção de comportamentos sustentáveis. Conduzimos sessões de grupos focais para descobrir necessidades dos utilizadores, exigências, problemas e desculpas razoáveis para não adotar ações de mobilidade sustentável e níveis de preferência/satisfação dos modos de mobilidade. Depois de traçarmos as oportunidades potenciais para um maior desenvolvimento, identificámos os comportamentos sustentáveis alvo, em que nos iriamos focar, em particular o caminhar e partilhar bicicletas, na vida da cidade. Na terceira fase, identificámos utilizadores-alvo, desenvolvemos personas e um cenário narrativo representando potenciais perfis de utilizadores e problemas. Ilustrámos storyboards, gerámos ideias. Apesar de o estudo se rever no paradigma sócio-critico, as soluções conceptuais geradas foram baseadas em Estratégias de Mudança de Comportamento e problemas observados em potenciais utilizadores, bem como em oportunidades futuras recolhidas a partir de relatórios de previsão e não apenas nas possibilidades tecnológicas atuais. Realizámos entrevistas de avaliação por peritos para alimentar a ideação, fazer a avaliação e refinamento das propostas, com a participação de especialistas em diferentes campos do saber, incluindo design de interfaces, produto, têxtil, moda, interação e ciência, incluindo engenharia, computador, física, software. Na quarta fase, visualizámos ideias conceptuais de produtos e sistemas com "storyboarding" de soluções. Desenvolvemos "mock-ups" e um protótipo em vídeo do vestuário de moda, para permitir a avaliação da experiência de utilização antecipada. O protótipo de vídeo forjou o que seriam as futuras ofertas de tecnologia inteligente em termos de interface e exibição do e-textile com animação por computador e ferramentas de edição de vídeo. Demos aos potenciais utilizadores a impressão de que estavam a interagir com um sistema real antes deste existir, o que proporcionou a tangibilização possível da solução para a fase de avaliação. Na última fase, avaliámos o desenho conceptual dum "fashionable wearable" para testar a motivação do utilizador em aderir ao comportamento desejável e a usabilidade do artefacto. Utilizámos o Questionário de Experiência de

Utilização (UEQ), avaliando a sua experiência considerando a perspicuidade, eficiência, estímulo, atratividade, novidade e fiabilidade do design conceptual. Obtivemos também feedback e sugestões dos utilizadores. O conceito foi avaliado positivamente. Encontrámos um estímulo significativo para a mudança de comportamento, que sugere que os artigos de moda, se usados como parte de uma estratégia de mudança de comportamento, podem influenciar a adoção de comportamentos mais sustentáveis no contexto da mobilidade urbana em cidades "inteligentes". Em última análise, esta investigação de doutoramento contribuiu para o campo do design de moda, design para comportamento sustentável, design para mudança de comportamento e sustentabilidade.

KEYWORDS Fashionable Wearables; Sustainable Behaviour; Smart City; Human-Centred Design; Design for Behaviour Change

ABSTRACT

The lack of sustainability that threatens our future needs urgent attention, requiring a holistic approach. However, actions explicitly aimed at changing human behaviour are not very common when, paradoxically, much of the environmental impact is associated with the behaviour of users in everyday life. Many unsustainable actions are currently taking place in cities, causing negative impacts. Cities offer access to many requirements of life that causes a population shift. Significantly, mobility facilitates access to all necessities of life in urban areas. Considering the potential to generate congestion, pollution and preventing freedom of accessibility, mobility can directly affect the quality of air and quality of life. Since cities are becoming smart thanks to emerging technologies, smart mobility has growing in importance and concerns more about being effective and sustainable. In this matter, mobility choices have a substantial impact on daily life. This study intended to promote mobility behaviours considered more sustainable through the design of fashionable wearables that can work as active elements of the system in the smart city context. The combination of body-related functionality and seduction, as well as the motivating power of fashion, combined with advanced technology and sensors, provided a strong motivation for contributing to behaviour change. The main objective was to explore how and to what extent solutions of fashionable wearables can promote more sustainable behaviours in smart cities. Mobility choices were selected as target behaviours that are desired to be altered. To achieve this, a mixed methodology according to the Human-Centred Design approach was used to gain information about needs and demands. Design for Behaviour Change strategies were used to provide solutions at a conceptual design level. We evaluated the conceptual design with a key element of fashionable wearable to test the motivation of the user to use and adhere the usability of the design to determine behaviour intervention. The conceptual design was evaluated positively, and we found the meaningful stimulus for the behaviour change.

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INTRODUCTION

As a beginning of our dissertation, this part introduces the problem definition and gives background of the study. It describes the motivation and objectives, it raises the research questions and outlines the methodological approach, ending with the thesis structure.

Problem Definition

Several global problems are threatening the future of societies, such as pollution, climate change, depletion of resources, and many others (The World Commission on Environment and Development, 1987; Mazzucato, 2018). Lack of sustainability is one of the key challenges requiring urgent attention and the adoption of mission-based approaches in an attempt to raise awareness (Mazzucato, 2018; European Union, 2011; ALLEA et al., 2017; General Assembly, 2015; Adams, 2006). It is known that the "use phase" of the life cycle is determined by the interaction between user and artefact, consuming other resources and generating waste during operation. Therefore, alteration of user interaction can significantly contribute to the overall environmental footprint, and "behaviour" is almost a component of the use phase (Lockton, 2013). In this matter, focusing on human behaviour and altering it towards a more sustainable state is a significant part of the contribution (Bhamra, Lilley, & Tang, 2011; Lilley, 2009; Sustainable Consumption Roundtable, 2006; Lockton, Harrison, & Stanton, 2010).

Although people are optimistic about sustainability and want to live in a way that treats ecosystems they depend on with care and respect, they find themselves in unsustainable daily behaviours that have negative environmental impacts (Manning, 2009). Different triggers can be listed for this outcome. Manning (2009) argues that people's rational minds may know that change is needed; however, it is not always the rational mind that drives the behaviour. Therefore, these behaviours might occur unconsciously. They find excuses to avoid the uncomfortable feeling (Festinger, 1957) or the "desirable" action such as buying second hand, taking short showers, using public transport is not appealing, and they are seen as lower status or undesirable (Manning, 2009; Sadalla & Krull, 1995). Here, we are facing a challenge: Just as Jackson asks (2005, p. 105): "How can we persuade people to behave in more

environmentally and socially responsible ways" when too many variables are needed to be considered to understand people's thinking and actions?

Design for sustainable behaviour or, more widely, a design intended to change behaviours is an emerging research area at the intersection of sustainable design and interaction design (Lockton, 2013). Researchers working in these topics are mainly concerned with a behavioural contribution to environmental and social problems, changing or influencing behaviour through several parameters (Lockton, Harrison, & Stanton, 2010; Lilley, 2009; Wendel, 2014; Niedderer et al., 2016). Positive and pleasurable interactions with objects, seductive design (e.g. Anderson, 2011) and motivation (e.g. Fogg, 2009; Wendel, 2014; Lockton, 2013) strategies are mostly asserted to change the cognition of individuals. Furthermore, informing, providing feedback or enlightening (Bhamra, Lilley, & Tang, 2011; Lidman & Renström, 2011) which are mainly making aware of users and making the desired behaviour simple (Daae & Boks, 2017; Fogg, 2009), which is briefly persuading, are some other highlighted strategies. Moreover, in order for sustainable innovation to be adopted by the intended users, design for behaviour change needs to facilitate a shift in the everyday behaviour of the population with the help of mentioned strategies (Crocker & Lehman, 2013; Niedderer et al., 2016).

Many concerns in the umbrella of encouraging sustainable behaviour and altering lifestyles towards environmental base are considered in the context of urban life (Manzini & Jegou, 2003; UNEP, 2011). It makes sense that many unsustainable actions are currently taking place in cities, with substantial impacts on the environment and the community itself that are foreseen to aggravate due to the increase in the pressure for urbanization. It is projected that nearly 60% of people are expected to live in urban areas by 2030 (United Nations, Economic & Social Affairs, 2016). The need for urbanization is addressed as "hope for a better life" (Eremia, Toma, & Sanduleac, 2017) and "hope to gain access" to all necessities of life, knowledge, other people, and some other opportunities (Etezadzadeh, 2016). However, people will need to deal with much more complexity in urban life, such as overpopulation, pollution, and depletion of sources. To deal with these issues, modern cities are increasingly becoming "smart" thanks to the Internet of Things (IoT) networks, requiring new and distinctive codes that take sustainable issues and information technology into account. In this sense, "smart" refers to technological and inter-connected, but also sustainable, comfortable, and safe (Sanseverino, 2014). However, many studies or reports that envision future smart cities emphasize individual mobility in the form of on-demand services (Vermesan, et al.,

2017; Viechnicki, Khuperkar, Fishman, & Eggers, 2015) which are basically another form of the taxi ride, autonomous vehicles (Giffi, Littmann, Westcott, & Scmith, 2019; Seuwou, Banissi, & Ubakanma, 2020) which are alternative for private car. Studies are also about improving private cars considering parking issues or other (Giffi, Littmann, Westcott, & Scmith, 2019). In this sense, individual mobility that requires private use in the traffic and other battery energy issues for electric versions need to be reconsidered in terms of sustainability. Of course, smart cities also provide improved versions of non-motorised or public-motorised transportation types with better digital applications, connected city elements, increased bike stations, and enhanced sharing options (Fishman, 2012; Hannon, McKerracher, Orlandi, & Ramkumar, 2016). In brief, smart cities can potentiate behaviour change that has both positive and negative consequences. As a result of this, the decision of people and how much they are motivated to adopt environmental behaviours are essential.

All in all, two different settings are in sight together for our society in the near future. One is in the form of environmental issues that raise serious global problems and the other in technology that provides smart and connected urban life. The main aim of this research was to contribute to sustainability by influencing sustainable behaviours in everyday life.

Motivation

The primary aim of this research was to contribute to sustainability by promoting sustainable behaviours. The main problem is how to find a way to shift consciously or unconsciously way of unsustainable acting and finding a meaningful tool to induce this behaviour change towards sustainability.

We believe that the power of fashion can alter this unconscious way of acting or "undesirable" actions. Fashion refers to the aesthetic, symbolic, emotional, and cultural meanings that objects carry, which people use to express their taste, identity, lifestyle, social status, and community participation (Pan, Roedi, Blevis, & Thomas, 2015). Pleasurable, fashionable objects can seduce users towards a behaviour change since they cause enjoyment and satisfaction, which influences intrinsic motivation (Ryan & Deci, 2000; Max-Neef, 1992). Additionally, fashion does not only contribute to aesthetics or style as it has other meanings. Fashion, in the context of apparel, also has other design characteristics as performing body-related functions, which makes it practical. Therefore, it provides physical and functional benefits (e.g., basic needs in everyday life, the human body's interaction, cheaper, reachable).

Besides, the technology recently embodied in smart products in everyday life easily brings information that affects cognition.

Various reports show an increasing dependence of our societies on digital technologies (e.g., wearables, worldwide network connectivity, IoT) in many basic activities (e.g., communication, socialization, learning, consumption) (The Innovation Group, 2018). Additionally, new technology-based possibilities are being suggested to solve many societal problems such as energy and waste reduction, water treatment, protection of natural systems (Eremia, Toma, & Sanduleac, 2017). Some examples of these technology-based solutions can already be found thriving in promoting safety, health/wellbeing, military training, and entertainment (Hanuska, et al., 2016). In this sense, "fashionable wearables", which are designed garments or accessories that combine aesthetics and style with functional technology (Seymour, Fashionable Technology, 2009), have the potential to empower sustainable behaviour.

To conclude, the main motivation is to explore the potential of fashion and technology to change behaviours. The emergence of technological solutions and the recent advances in fashion, along with the potential social contributions, are the great motivations for the study to happen.

The Scope

This PhD thesis is situated at the intersection of sustainable behaviours, fashionable wearables and smart cities from the perspective of design. Design perspective plays a significant role in this matter. The definition of the term could be beneficial to understand this role. Literature uses the term design in numerous ways. Alexander (1964) defines "design" as the process of inventing objects which are "things" that perform specific functions. These "things" that are the production of human's intelligence and effort are called "artefacts" (Simon, 1969). Artefacts could be both tangible, such as automobiles, kettles or computers and intangible, such as rules, law systems, science or knowledge (Baldwin & Clark, 2000). Binder, et al (2011) highlight the shift in the word "thing" reflects on the practice of design: "A major challenge for design today has to do with what is being designed — not just a thing (an object, an "entity of matter") but also a *thing* (a socio-material assembly that deals with matters of concern)". Therefore, these new things improve the new ways of thinking and behaving (Binder, et al., 2011).

Starting from finding solutions in primitive conditions, such as designing basic tools to goods, services and knowledge, design is one of the activities that made us human in the first place (Muratovski, 2016) and it is still improving our lives in new ways every day. As Baldwin and Clark (2000) states, artefacts or things evolve, and eventually, the meaning of design evolves.

Stappers and Giaccardi (n.d.) highlight the "doing design" expression instead of the noun "design" to emphasise the design activity and define it as "Work done with the intention to produce a feasible solution to improve a given situation". Therefore, the goal of design is to improve a situation or a problem. Of course, this given situation or problem needs to be structured or formulated instead of "merely accepting the problem as given" before generating feasible solutions (Cross, 2006). Design can be summarized as a complex activity that deals with many problems not only to structure or solve them but also face them during the process. Buchanan (1992) addresses design problems as "indeterminate" and "wicked" because the design has no special subject matter of its own apart from what a designer conceives it to be. Topics of design are potentially universal in scope because design thinking can be applied to anything related to human experience. As human beings, we are experiencing many "things" today, differ from what we experienced before. Therefore, problems of everyday life diversify and incorporate knowledge from many fields of specialized inquiry (Buchanan, 1992).

The expansion of the scope of design adds new roles to the designer of the 21st century and new areas of design focus to represent ways of framing and solving problems (Iwabuchi, 2019). For example, the definition of the product or industrial design, which are the widespread terms in design practice, might explain the new roles of the 21st-century designer. Product design and industrial design are the terms that literature uses interchangeably (Heskett, 2002) and they are not only related to the "product" or "industry" as we know before anymore. We will highlight the extended definition of industrial design by World Design Organization (WDO) that was announced in 29th General Assembly (2015) and adopt this definition.

> Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. Industrial Design bridges the gap between what is and what's possible. It is a trans-disciplinary profession that harnesses creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or a business, better. At its heart, Industrial Design provides a more optimistic way of looking at the future by reframing problems as opportunities. It links innovation, technology, research, business, and customers to provide new value and competitive

> advantage across economic, social, and environmental spheres. (World Design Organization, n.d.)

For this study, we developed a conceptual design that focuses on a smart fashion product which we called “fashionable wearable” aiming to transform the future society for more sustainable actions. Designing a concept that is to make an effort to create a combination of solutions through the intersection of system, interface, communication, aesthetics and others should be highlighted instead of designing a single product. The conceptual design is just an exercise and part of the research process, not the core.

The main objective of this study is to promote more sustainable behaviours in everyday life based on serious sustainability issues that our society faces. We are addressing the problem of adopting unsustainable behaviours from the eyes of design. As we clearly see in the extended definition, design is a significant driver of innovation, technology and sustainability. It also provides an optimistic way of looking at the future by reframing problems as opportunities, which leads to a better quality of life. This wide role of design links with numerous concerns or priorities and creates many fields, methods, and techniques that highlight society, transition, sustainable behaviour, future, speculation, human, and more. Taking the potentiality of design and link between future, technology, social and environmental spheres, the scope of this study is the transformation of future societies that live in smart cities for adopting sustainable behaviours with the perspective of Human-Centred Design and Design for Behaviour Change.

Research Questions

The main research question is:

- Can fashionable wearables promote sustainable behaviours as part of a strategy for behaviour change in the smart city context?

The secondary research questions are:

- Which are the behaviours in city life that more negatively impact sustainability?
- Which are the main obstacles that prevent users from adopting more sustainable behaviours?
- Which are the purposes of fashionable wearables inside a strategy for behaviour change?

- Which properties should fashionable wearables have to be well succeeded for this purpose?
- How can we assess the impact of fashionable wearables as actors for behaviour change?

Objectives

The aim of this research is to contribute to sustainability, and the main objective is to explore how and to what extent solutions of fashionable wearables can promote more sustainable behaviours in the choice of mobility mode in smart cities.

To achieve the main objective, the following specific objectives were established:

The general perception of sustainability: Comprehend the current understanding of sustainability and identify users' awareness of their behaviours' impact on sustainability;

Define behaviours and identify obstacles: Identify the behaviours with more impact on sustainability and the obstacles (e.g., attitudes/motivations, expectations, fears, needs) that prevent users change/adopt other behaviour;

Fashionable wearables: Map and describe the fashionable wearables solutions that exist or are emerging and define how they could match with the selected behaviours;

Develop a solution: Design fashionable wearable concept solutions according to behaviour change strategies under a human-centred design approach;

Evaluation: Assess the acceptance and the impact of the solution in the context of intervention.

Methodological Approach

A mixed methodology of exploratory nature was used to conduct this study, which is one form of triangulation that allows researchers to obtain data from various sources (Lilley, 2009). It involves collecting, analysing, and integrating both qualitative and quantitative data (Leavy, 2017) to explore, identify, generate and verify findings to meet research objectives. The methodology followed a Human-Centred Design (HCD) approach, which was used to

gain information about people's needs and perceptions and test the perceived experience of the potential users.

The methodology was divided into five phases: (1) Understand, (2) Discover, (3) Conceptual Design, (4) Prototype, and (5) Evaluate (Figure 1).

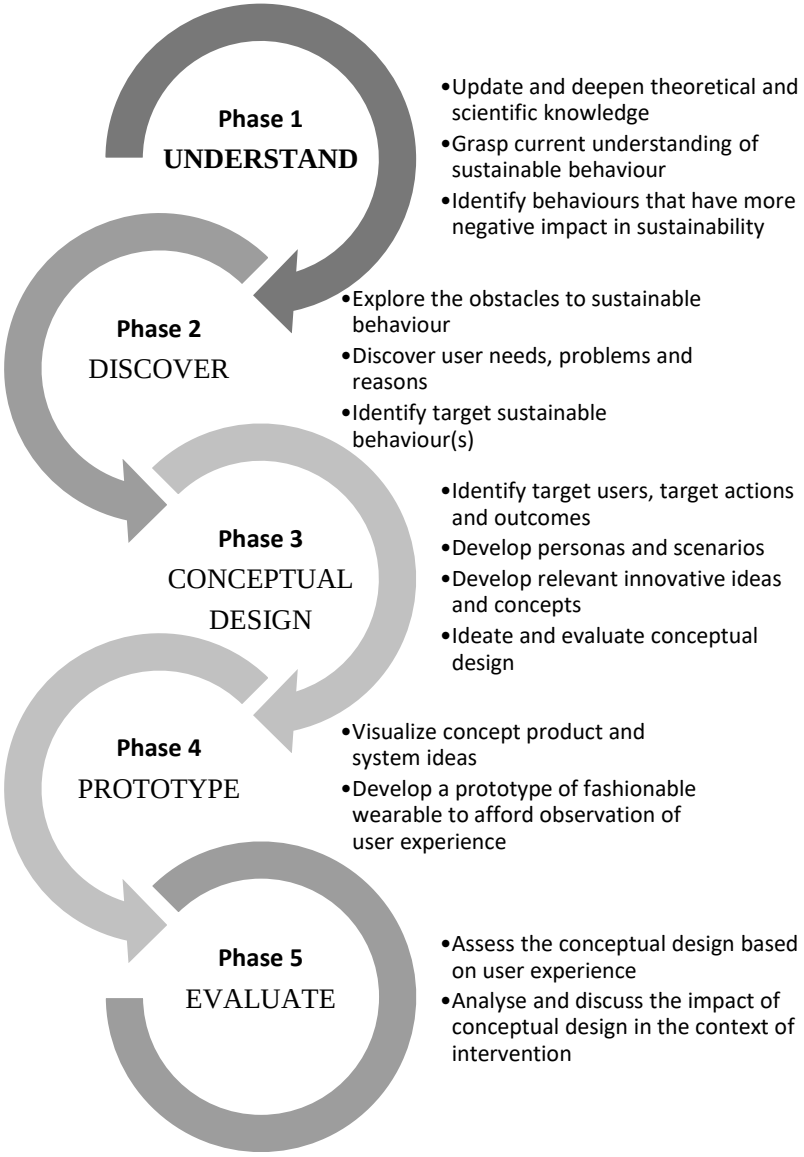


Figure 1. Methodological structure and objectives of phases

Structure of the Dissertation

The document consists of five chapters that are outlined below:

Introduction covers some of the backgrounds of the thesis mainly to define the problem state and the core motivation of the research. It describes the objectives and raises the research problems. It ends by outlining the thesis structure and each chapter.

Chapter 1 (Literature Review) examines related literature and the overlaps of relevant research outcomes in the field of sustainability, sustainable behaviour, smart cities and fashionable technology. The main outcome is identifying critical debates in the target topics, including theories and previous studies of researchers in the field, to find out the opportunities.

Chapter 2 (Methodology) describes the overarching strategy and the approach for conducting the research to meet the objectives. It explains the selection and justification of the methodology in detail. The procedure of the study, phases and methods, measurement tools that are used for data collection are also described.

Chapter 3 (Research Development, Results and Discussion) outlines the findings related to the research questions, discussion of analysis, and interpretation of data gathered from each step. The chapter is structured corresponding to the research phases, and it also explains the methodology of phases.

Conclusion summarizes the thesis and evaluates the research questions of the study. It demonstrates that the research objectives have been met and reflects upon the limitations of this research. The recommendations for future studies and the contribution to knowledge made by this research are also presented.

Appendices contains supplementary information that has been gathered to provide more comprehensive understanding of research materials, detailed analysis and raw data. It presents interview transcripts, survey instruments and questionnaires, raw data of qualitative and quantitative analysis. Published papers and book chapters that are outputs of this PhD study are also presented in their original form.

CHAPTER 1

LITERATURE REVIEW

This chapter examines the literature and the overlaps of relevant research outcomes in sustainability, smart cities and fashionable technology fields. The main objective of this chapter is to identify key debates in the target topics, which includes theories and ideas of researchers in the field for finding out the gap of knowledge and the opportunities.

The content of this chapter has been partially presented at the 5th Design Doctoral Conference: TRANSgression in Lisbon in 2018 and subsequently published in the conference proceedings as: Ayanoglu, S.G.; Duarte, E.; Pereira, M. (2018). Promoting Sustainable Behaviour Through Fashionable Technology, 5th Design Doctoral Conference: TRANSgression, Lisbon, Portugal 23-30. ISBN: 978-989-8473-25-7 (see Appendix Q).

1.1 Sustainability

The transition to sustainability has introduced new ideas and behaviours as well as ambiguity (Manning, 2009; Sartori, Latronico, & Campos, 2014). This growing interest in sustainability has added many different approaches regarding strategies, pollution control, social responsibility, green economy, eco-design and many others on application (Sartori, Latronico, & Campos, 2014). Although the idea of the concept dates back more than 40 years now, it is hard to define since “it can be used to cover very divergent ideas”; furthermore, “holistic, attractive, elastic but imprecise” (Adams, 2006).

The term sustainable development was coined by the Brundtland Commission in 1987 and is defined as “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (The World Commission on Environment and Development, 1987). Sustainability is represented as an end point of sustainable development, in the sense that a holistic approach to sustainable development is required to achieve sustainability (Sartori, Latronico, & Campos, 2014; Prugh & Assadourian, 2003). In this sense, the goal of sustainability is to fulfil both present and future generations’ requirements. These requirements are defined as three pillars, which are social, environmental

and economic. Sustainability is the balance between the three pillars for Elkington (1994), who created the term “Triple Bottom Line: people (social), planet (environmental) and profit (economic)”. Later, he defined sustainability in his book as “the principle of ensuring that our actions today do not limit the range of economic, social, and environmental options open to future generations” (Elkington, 1997). Other than this perspective, other policy initiatives such as Agenda 21 for culture and United Cities and Local Governments (UCLG) introduced “culture” as a dimension of sustainable development since the Triple Bottom Line may not seem to be enough to reflect the complexity of contemporary society (UCLG, 2008; Soini & Birkeland, 2014). Even though cultural sustainability has been categorised under the social pillar, culture is introduced and discussed among scholars (Hawkes, 2001; Chiu, 2004; Birkeland, 2008). It is emphasized that the culture is both an enabler and driver of the Triple Bottom Line pillars (Soini & Birkeland, 2014).

Lack of sustainability is one of the key challenges that our society faces, raising many global problems that threaten our future, such as pollution, climate change, depletion of resources, ecological devastation, and global inequity (The World Commission on Environment and Development, 1987; Mulder, Ferrer, & Van Lente, 2011; Mazzucato, 2018). European Union (2011), in Horizon 2020, has identified critical societal challenges requiring urgent attention, which are (i) health, demographic change and wellbeing; (ii) food security, sustainable agriculture, marine and maritime research and the bio-economy; (iii) secure, clean and efficient energy; (iv) smart, green and integrated transport; (v) climate action, resource efficiency and raw materials; and (vi) inclusive, innovative and secure societies. Although these challenges are not new, recent reports suggest the adoption of mission-based approaches in an attempt to raise awareness about societal challenges (Mazzucato, 2018; European Union, 2011; ALLEA et al., 2017; General Assembly, 2015). General Assembly’s (2015) 2030 Agenda for Sustainable Development is “calling for action to change the world” and announces 17 goals and 169 targets to stimulate action in the critical importance for humanity and the planet (Figure 2).

Figure 2. Sustainable Development Goals (United Nations Development Programme, 2018)

These recent reports demonstrate how the concern about the lack of sustainability is serious worldwide. It also reveals that this issue is acknowledged by great amount of people and leading organisations; however, also show that there is no significant proof of absolute achievement, additionally requiring for more contribution. Adams (2006) addresses this problem as ignorance in practical decisions that cause rhetoric of sustainable development. Furthermore, the concept is "complex and ongoing" (Sartori, Latronico, & Campos, 2014), and the idea of sustainable development may unite people but not necessarily support them to agree on the goals. What needs to be understood in this matter is, how to make a balance the interests of different people and environmental outcomes (Adams, 2006).

1.1.1 Sustainable Behaviour

The promotion of sustainable habits, having the people and their behaviours as a starting point for the change, has been suggested to achieve sustainability by various researchers in the field (e.g. Bhamra, Lilley, & Tang, 2011; Lilley, 2009; Sustainable Consumption Roundtable, 2006). For many products, the use phase, where people interact with artefacts, contributes most of the total environmental impacts and is often determined by user behaviour (Lidman & Renström, 2011). Despite declaring being generally concerned with sustainability, people are often engaged in unsustainable behaviours or, at least, resist adopting others that are being suggested, stressing the need for motivation and empowerment of sustainable actions

(Manning, 2009). In this sense, understanding human behaviour, which underlines a behavioural change towards sustainability, is essential.

Human behaviour refers to a range of actions made by humans typically influenced by several determinants (Hemakumara & Rainis, 2018). According to the Theory of Planned Behaviour (Ajzen, 1991), these independent determinants are "attitudes towards behaviour", "subjective norms", and "perceived behavioural control", and they contribute to the behavioural intentions that inform later actions. Behaviour is mainly a response to various stimuli or inputs, unconscious or subconscious, voluntary or involuntary. When these responses or actions focus on the overlap of environmental, social, and economic concerns, sustainable behaviour can be considered.

Various factors need to contribute to an individual behaving in a particular manner. People do not always behave reasonably or logically and are often affected by a number of cognitive, social and memory biases (Filippou, 2017). Manning (2009) claims that most people want to live in a way that treats ecosystems we depend on with care and respect, even though they find themselves in unsustainable daily behaviours with negative environmental impacts. People's rational minds may know that change is needed; however, not always the rational minds drive the behaviour. People think in two different cognitive systems of reasoning: A rule-based, which is reflective, conscious, self-aware, and an associative system which is automatic, unconscious, sensory-driven (Sloman, 1996; Thaler & Sunstein, 2008). Manning (2009) addresses the problem of sustainable behaviour as having little appeal to the associative system:

> *Consider a behavior like biking to work: a person's rule-based system thinks it's a great idea because of all the benefits (health, money savings, fitness), but his associative system responds with a definitive "No way!" perhaps because it just can't handle the idea of walking into the office with "helmet hair." One way to empower sustainability is to make sustainable actions appealing to the associative system (…) A second strategy is to get the attention of the rule-based system so that it can assert itself against the associative system's rejection of a sustainable action ("Helmet hair is really no big deal. We're biking!")* (Manning, 2009, p. 3).

People find excuses such as the concern of appearance, "helmet hair" or other emotional, physical, individual concerns for lack of sustainable behaviour. Hult (2008) identifies four common excuses that allow people to feel justified when not performing environmental behaviour:

> *(a) I want to, but I do not have enough time, or I do not manage it*

(b) I want to, but it is not my responsibility
(c) I want to, but it turns out wrong anyway
(d) I actually do some things (adapted from Lidman & Renström, 2011, p.23-24).

These conflicting attitudes, beliefs or behaviours and lack of agreement were initially defined in the "Theory of Cognitive Dissonance" (Festinger, 1957). According to the theory, people tend to seek consistency in their cognitions. When there is an inconsistency, being psychologically uncomfortable, will motivate a person to reduce the dissonance. Dissonance can be reduced in three basic ways: changing beliefs, changing actions, and changing perception of action. Since the critical part is to avoid the uncomfortable feeling without changing beliefs or actions, people rationalize the actions. Despite the knowledge of endangering the health, a person may continue to smoke and come up with these excuses:

(a) he enjoys smoking so much it is worth it;
(b) the chances of his health suffering are not as serious as some would make out;
(c) he can't always avoid every possible dangerous contingency and still live; and
(d) perhaps even if he stopped smoking, he would put on weight which is equally bad for his health (Festinger, 1957, p. 2)

To sum, due to thinking about the unpleasant action in a different manner and context, people can get rid of the inconsistency between the beliefs and actions. The excuses in Hult's (2008) findings related to sustainable behaviours also suggest the exact resolution for inconsistency. People want to be sustainable; however, the current life situation does not allow them. They are either not able to see the difference immediately when they sustainably change their behaviours or are witnesses to irresponsible people who make their effort useless. These excuses turn their unsustainable actions "reasonable". Based on this difficulty in understanding the way of people's thinking and trickery perception, it is pretty challenging to have an expectation from people to easily change their behaviour towards sustainability.

1.1.2 Sustainable Lifestyles

Many unsustainable actions are considered perfectly normal, such as driving alone, living in a huge house that requires unnecessary heating, eating foods that have travelled long distances, constantly shopping for new products. However, sustainable behaviours, such as buying second-hand products or taking short showers, are considered lower status or undesirable for some people (Manning, 2009; Sadalla & Krull, 1995). Many other behaviours that take place in everyday life compose lifestyles. Plus, lifestyles represent how humans interact with each

other in their decisions and choices that can substantially impact the environment and community itself.

Lifestyle refers to a pattern of consumption reflecting people's choice of spending time and money and the attitudes and values attached to these behavioural patterns (Solomon, Bamossy, & Hogg, 2006). Patterns of choices or demands based on lifestyles mainly consist of many components shared by others in similar social and economic circumstances; however, each person provides a unique "twist" to this pattern and makes each lifestyle unique. Solomon, et al (2006, p. 558) give this example: "a 'typical' student may dress much like his or her friends, go to the same places and like the same foods, yet still indulge a passion for running marathons, stamp collecting or community service, activities which make him or her unique". This unique twist, which can be rephrased as seeking individuality, might surface in various activities, interests, or opinions. These three categories of variables - activities, interests and opinions (AIOs)- are suggested as the dimensions to assess lifestyles (Table 1). Wells and Tigert's (1971) psychographic research argues that one can understand lifestyle "by discovering how people spend their time, what they find interesting and important and how they view themselves and the world around them, as well as demographic information" (Solomon, Bamossy, & Hogg, 2006).

Table 1. Wells and Tigert's (1971) lifestyle dimensions (adapted from Solomon, Bamossy, & Hogg, 2006, p. 563)

Activities	**Interests**	**Opinions**	**Demographics**
Work	Family	Themselves	Age
Hobbies	Home	Social issues	Education
Social events	Job	Politics	Income
Holiday	Community	Business	Occupation
Entertainment	Recreation	Economics	Family size
Club membership	Fashion	Education	Dwelling
Community	Food	Products	Geography
Shopping	Media	Future	City size
Sports	Achievements	Culture	Stage in life cycle

Variables that compose lifestyles underlie the behaviours of individuals in a particular way in the setting of everyday life. One of the recent projects that the European Union funds outline 12 strategies that can be used to promote sustainable behaviours in people's everyday life including both what is commonly called "Nudge" (Thaler & Sunstein, 2008) and "Think"

(John, et al., 2013) behavioural approaches (Petersson, 2016). These strategies are listed in the following (Table 2). Each strategy also suggests themes such as recycling, eating habits, sustainable consumption, reducing waste, and target groups such as restaurant costumers, workplaces, local community, etc. Given examples or projects related to the strategies are not strictly divided but also transitional between each other. Similar to other behaviour change approaches that we will review in the following topic in detail, keywords like "encouragement", "motivation", and "guidance" are frequently seen.

Table 2. 12 Strategies to promote behaviour change by enabling sustainable choices (Petersson, 2016)

Strategies	Purpose	Some Examples
GREEN BY DEFAULT	To enable behaviour change by making sustainable choices easy and/or by making unsustainable choices difficult.	Reducing food waste by plate size Energy-efficient light bulb
USE SOCIAL NORMS	To encourage sustainable behaviour by informing people about the action of others.	Towel re-use at hotel chains Energy consumption among households Using peer effect to encourage giving
ATTRACT ATTENTION	To use new smart/inventive ways to attract attention and remind people of the behaviour that is desired.	Nudging litter into the bin using green footprints Visualizing energy use
GIVE FEEDBACK	To explore new and creative ways to reward people and show them why their actions matter.	Using happy face to encourage low energy consumption
SMART INCENTIVES	To understand why and when incentives can be an effective way to make people start acting green.	Getting children to eat fruit and vegetables by using early rewards
GAIN COMMITMENTS	To seek ways that encourage people to make a promise about changing their behaviour.	Using pledge to reduce the water consumption of households
CREATE NEW HABITS	To help people change their habits by breaking them down into smaller parts and planning how, when, and where to make changes.	Encouraging recycle behaviour at work Personalized travel planning Free public transport during first months
FORM TEAMS	To motivate people to change behaviour by working together with others towards a common goal.	Working in teams to reduce energy consumption
TRIGGER RECIPROCITY	To encourage pro-social and environmental acts and commitments by giving people something unexpected.	Encouraging voluntary donation by using a "thank you gift."
ENGAGE VALUES	To strengthen values that have been shown to correlate with sustainable attitudes and behaviour.	Increasing pro-social attitudes by promoting acts of kindness Kindness handbook for primary schools
CONNECT TO	To increase people's motivation to act	Engaging people in activities such as

NATURE	and live sustainably by strengthening their connection to nature.	urban farming, guerrilla gardening, cleaning beaches
AVOID DENIAL	To avoid spreading information that triggers negative attitudes towards sustainability.	Dire messages reduce belief in global warming

Creating sustainable lifestyles, which means rethinking the ways of living and individual actions (UNEP, 2011), is quite essential to empower sustainable behaviour. Creating this particular type of lifestyle also means rethinking how people organize their daily life, altering the way they socialize, exchange, share, educate and build identities. It is about transforming society towards more equity and living in balance with the natural environment.

"Everyday life" or "lifestyle" expressions are primarily highlighted in studies about sustainability, particularly those addressing behaviour (Manzini & Jegou, 2003; UNEP, 2011; Petersson, 2016; Thieme, et al., 2012; Barr & Gilg, 2006; Marchand & Walker, 2008). Furthermore, many concerns in the umbrella of encouraging sustainable behaviour and altering lifestyles towards environmental base are considered in the context of urban life (Manzini & Jegou, 2003; UNEP, 2011) as well as inside and around the home (Barr & Gilg, 2006).

A flagship example on the topic of sustainable lifestyle is Manzini and Jegou's (Manzini & Jegou, 2003) sustainable scenarios in urban life. In this project, the point of reference is "the daily dimension of human's existence", and two complimentary meanings under this theme are claimed: "the world is seen by those who live in it" and as a sociotechnical system that can be operated on through "strategies of bottom-up intervention", starting from the local environment. The project offers possible scenarios and practicable alternatives by answering this question: "What might life be like in sustainable society?". A set of suggested solutions, in prepared scenarios, are divided into different topics, which are listed as "eating", "things", "work", "cities", "energy" and "vegetation". However, to reach the objective, the questions related to the activity itself, are suggested as a starting point of scenarios (Table 3). The United Nations Environment Programme (UNEP) also welcomes these scenarios and additionally provides recommendations for effective policies based on The Global Survey on Sustainable Lifestyles (UNEP, 2011).

Table 3. Main topics of suggested solutions for sustainable everyday life (Manzini & Jegou, 2003)

Topics	Starting point
Eating	How do you prepare food?
Things	How do you take care of things and the house?
Work	How do you work, and how do you study?
Cities	How do you move around the city?
Energy	How do you produce and use energy?
Vegetation	How much vegetation is there, and how do you look after it?

Another example was UNEP's (2011) Global Survey asking young adults living in urban areas from 20 countries to examine their current lifestyles. The survey's main objective was to analyse young adults' perceptions and attitudes in everyday life and the visions of sustainable lifestyles, encourage the participation of sustainable scenarios, and develop policy recommendations, focusing on opportunities, actors, and responsibility. Sustainable lifestyles were divided into three major climate-related areas: "mobility", "food", and "housekeeping". "They are also three major consumption areas that have great impacts on environments and societies and need to be looked at closely to tackle global challenges such as climate change" (UNEP, 2011, p. 18). These areas are rephrased to emphasise and understand the activities related to the three "major climate-related areas":

- Housekeeping: Being at home
- Food: Getting some food and eating
- Mobility: Getting around, getting out

Nine scenarios were designed for the three major areas of the survey. For each area, three types of scenarios were suggested as well: Quick, Slow, and Co-op (Figure 3). The research also highlights that poverty, and the environment are serious concerns, the desire for a good quality of life and the ability to affect change is high. Plus, infrastructure changes are needed in every country, and there is a significant demand for sustainable lifestyles even though it is not a priority in people's minds.

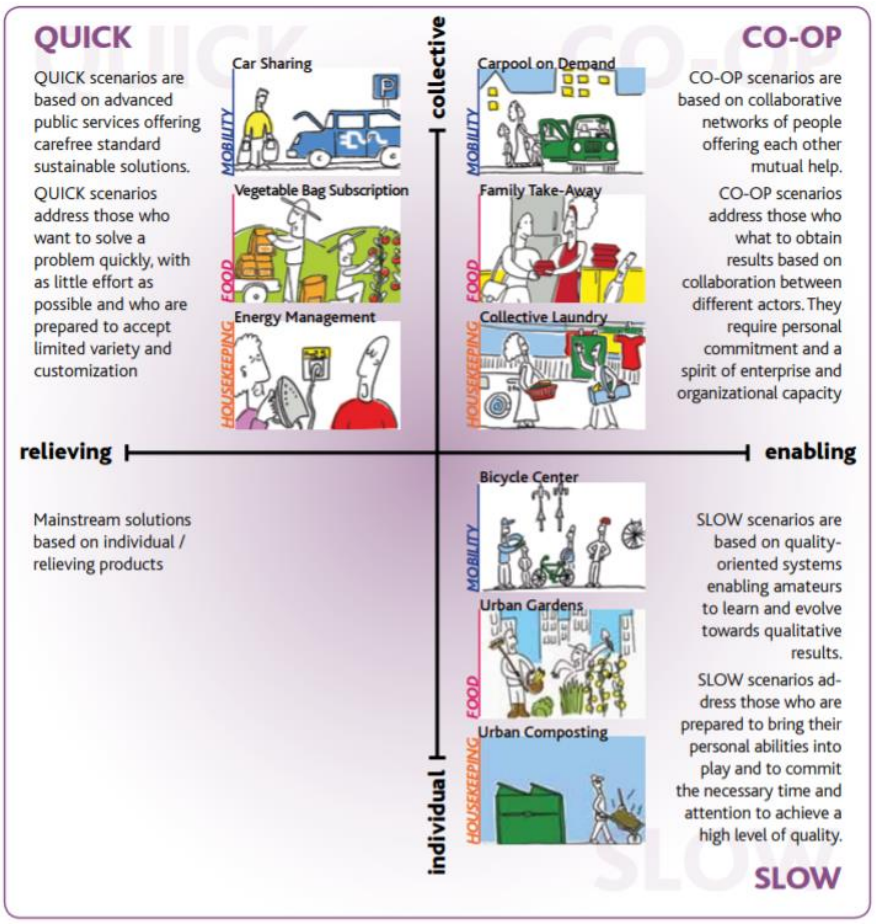


Figure 3. Scenarios for Sustainable Living (UNEP, 2011, p. 42)

Recently, another UNEP report proposed an "evidence-based framework design" to enable lifestyle choices that contribute to sustainability (Akenji & Chen, 2016). The report argues that there are encouraging signs that society understands the impact of daily choices, and the various ways of actions, models, and surveys are helping people to live more sustainable lifestyles. However, there is still the need for a holistic vision of what constitutes a sustainable lifestyle. In this matter, based on consumption categories and groups of products that have the highest environmental impacts, as well as "equally problematic" social impacts, the key domains are proposed as "food", "housing", "mobility", "consumer goods" and "leisure" (Table 4). Additionally, water, energy, and waste were not addressed in isolation but as cross-cutting elements affecting almost every lifestyle domain (Akenji & Chen, 2016, p. 5).

Table 4. Key lifestyle domains and the brief content based on Akanji and Chen's (2016) UNEP report

Key life-style domains	**Content**
Food	What we eat/drink, how it is produced, processed, provided and disposed

Mobility	How/how often we travel
Housing	How/Where we live, what is used to build, heat and cool
Consumer Goods	The type/quantity of products we buy, how we use and how often we replace
Leisure	How we spend leisure time, choice of tourism destinations, activities, how we use facilities

This framework is not only highlighted for proposing the domains of daily life, but also the components of "everyday sustainability actions" (REDuse), which are formed as Refuse, Effuse and Diffuse. "Refuse" targets negative-impact activities and actions by individuals/households to avoid or reduce unsustainable practices. "Effuse" targets positive impact activities by individuals/households that are sustainable. Finally, "Diffuse" carries out collaborative engagement actions with wider communities that provide solutions and reduce environmental impact. These components are used to categorize behaviour types in terms of sustainability.

1.1.3 Behaviour Change for Sustainability and Related Approaches

Changing user behaviour through product, service, or system design is a growing research field of concern. Behavioural design studies to design strategies, develop models to influence sustainable user behaviour and promote sustainable usage, have expanded the field rapidly (e.g. (Lilley, 2009; Tang, 2010; Lockton, Harrison, & Stanton, 2010; Lidman & Renström, 2011; Wever, Kuijk, & Boks, 2008). Some strategies, models and toolkits were defined in the umbrella of "Design for Sustainable Behaviour" (e.g. Lilley, 2009; Wever, van Kuijik, & Boks, 2008), and some were "Design for Behaviour Change" (e.g. Lockton, Harrison, & Stanton, 2010; Niedderer, et al., 2016) mainly influenced and enhanced from the theories of behavioural studies (Spencer, 2014).

Growing research field suggests that understanding behaviour and influencers of behavioural change are important. While there are numerous theories about physiological and psychological needs, values, attitudes, incentives, and habits that can be used to define or change human behaviour (Lidman & Renström, 2011), different and overlapping approaches have been practised. Niedderer et al. (2016) overviewed several concepts, theories, design methods, guidance and tools between 2000 and 2014 and grouped them according to different lenses, demonstrating a variety of approaches in the field (Figure 4). In addition, Niedderer, et

al.'s (2016) study surveyed the private and public sector stakeholders in terms of their current knowledge of design for behaviour change and identified that they used three approaches: (i) The Loughbourough Model (Lilley, 2009), (ii) The Design with Intent Toolkit (Lockton, Harrison, & Stanton, 2010) and (iii) The Fogg Behavioural Model (Fogg, 2009).

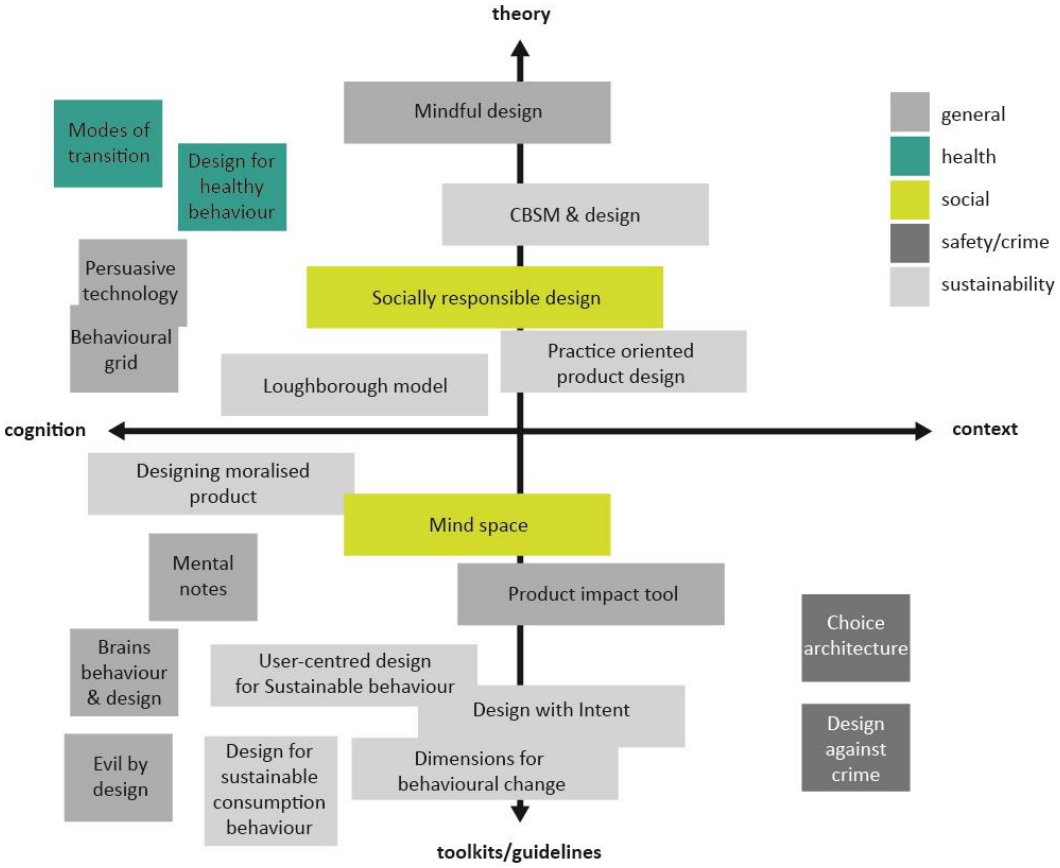


Figure 4. Overview of theories and models by agency divide, knowledge level and subject approach (adapted from Niedderer, et al., 2016)

Lilley (2007) introduced three behaviour change strategies in sustainable design by dividing interventions to change behaviour into educational, technological, and product-led interventions (Figure 5). The product-led intervention comprises eco-feedback, behaviour steering and intelligent products and systems. On Lilley's (2009) further work, which is referred to as "The Loughbourough Model" (Niedderer, et al., 2016), these three strategies were redefined as eco-feedback (guiding), behaviour steering (maintaining) and persuasive technology (ensuring). Lilley's approach became a baseline for further studies.

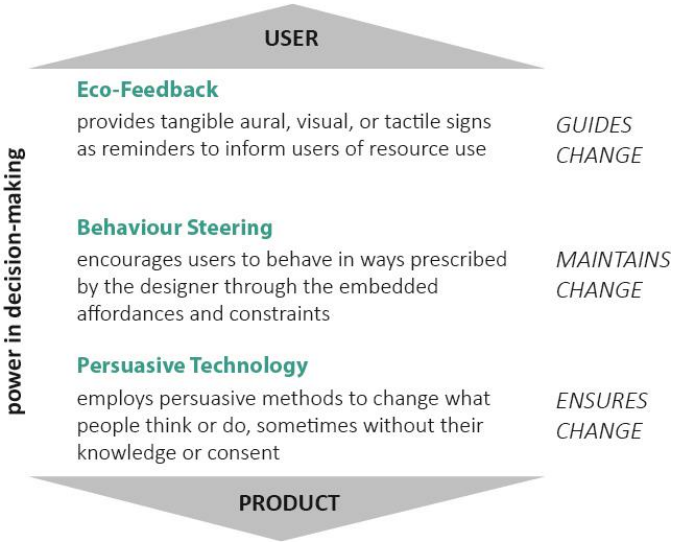


Figure 5. Strategies for designing sustainable behaviour (adapted from Lilley, 2009)

Wever, et al. (2008) enhanced Lilley's strategies by proposing eco-feedback, scripting and forced functionality. The distinction is in the term "forced functionality", which refers to either intelligent products or systems to adapt directly to changeable situations or designing obstacles to prevent unsustainable behaviour (Wever, Kuijk, & Boks, 2008). Additionally, a second branch was proposed, "functionality matching", defined as eliminating mismatches between delivered functionalities and desired functionalities. The suggestion is to adapt a product to fulfil the user's demand. Missing functionalities can trigger unwanted behaviour such as putting garbage bags beside the bin instead of putting them inside because of lack of capacity. Increasing the capacity of frequently used bins is an example of "functionality matching".

On another approach building on Lilley's work, Tang (2010) extended the three strategies based on seven interventions for behavioural change that can be applied in a design context (Figure 6). These were (1) eco-information (2) eco-choice (3) eco-feedback (4) eco-spur (5) eco-steer (6) eco-technology and (7) clever design. Some strategies were overlapping in terms of main intentions, such as informing users by visualising, providing choices or giving feedback. The intention was to offer guidance, but strategies were detailed. Distinctively, the "clever design" term was used to suggest "innovative design solutions" to decrease environmental impacts. Nevertheless, the intention was to ensure the change, which can also be considered as a persuasive method.

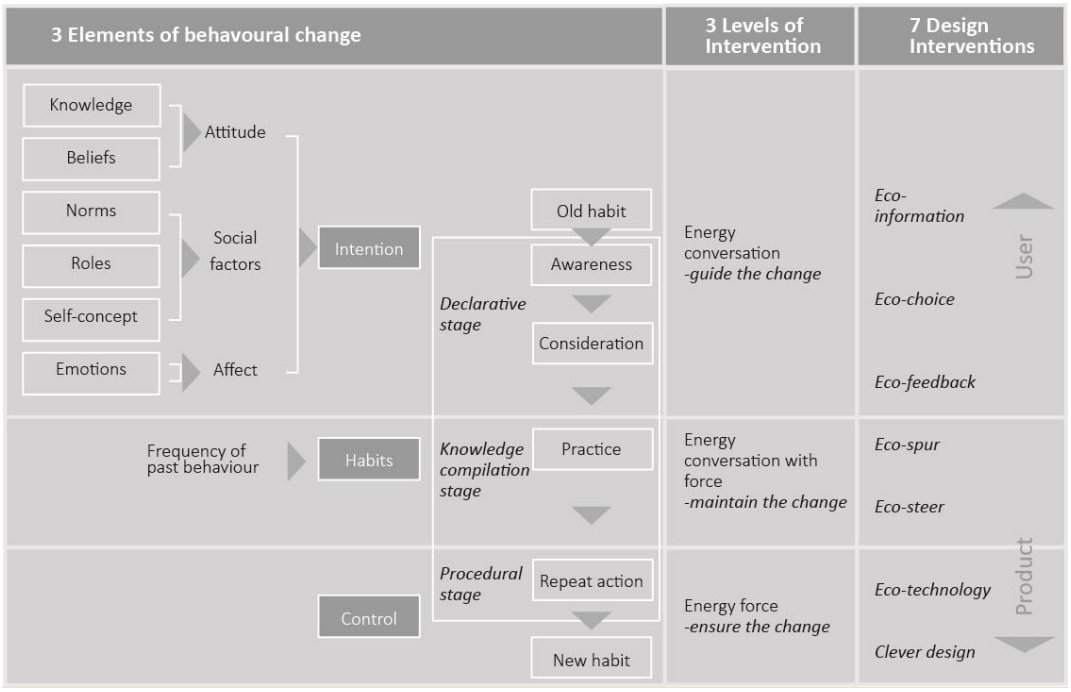


Figure 6. Tang's (2010) Design Behaviour Intervention Model (adapted from Bhamra, Lilley, & Tang, 2011)

"The Design with Intent Toolkit" (Lockton, Harrison, & Stanton, 2010) combined multiple tools and techniques for influencing desirable user behaviour, primarily for environmental and social benefit. Since every product, service or system that were designed affects, intentionally or not, human behaviour, the toolkit's objective was to bring some techniques in the range of psychological disciplines to induce a certain user behaviour. But not necessarily in the context of sustainability. The toolkit consisted of a set of cards which were divided into six lenses (Table 5) that were a way of grouping design patterns that share similar considerations, behavioural understanding or assumptions about how to influence users: (1) Architectural (2) Errorproofing, (3) Persuasive, (4) Visual, (5) Cognitive and (6) Security—resolve into particular "worldviews" (Lockton, Harrison, & Stanton, 2010, pp. 387-388). Design with Intent thinking is mainly a strategic design to guide, shape or regulate the ways in which interaction occurs.

Table 5. Design with Intent lenses with brief description and patterns (adapted from Lockton, 2013, p. 141)

Lens & Patterns	Description
Architectural Lens Positioning & Layout; Material Properties; Segmentation & Spacing; Orientation; Removal; Movement & Oscillation	Techniques for encouraging behaviour used in architecture, urban planning and related disciplines.
Error proofing Lens	Techniques for avoiding deviating from target behaviour

Defaults; Interlock; Lock-In & Lock-Out; Extra Step; Portions; Conditional Warnings; Partial Self-Correction; Specialised Affordances	often found in health & safety-related design, medical device design and manufacturing engineering.
Persuasive Lens Self-Monitoring; Kairos; Simulation & Feedforward; Reduction; Tunnelling; Tailoring; Computers as Social Actors; Feedback Through Form; Operant Conditioning; Respondent Conditioning	Represents the emerging field of persuasive technology, where devices or systems with interfaces are used to persuade users: changing attitudes and so changing behaviour through contextual information, advice and guidance.
Visual Lens Prominence & Visibility; Metaphors; Implied Sequences; Proximity & Similarity; Perceived Affordances; Colour & Contrast; Watermarking; Possibility Trees	Techniques based on how users perceive patterns and meanings, which are often applied by interaction designers, combine ideas from product semantics, semiotics, ecological psychology, and Gestalt psychology.
Cognitive Lens Social Proof; Framing; Affective Engagement; Scarcity; Commitment & Consistency; Reciprocation; Authority	Techniques based on how people make decisions and how this is affected by heuristics and biases.
Security Lens Surveillance; Atmospherics; Threat of Damage; Where You Are; Who You Are; What You Have; What You've Done; What You Know or Can Do	Techniques based on a `security' worldview that undesired user behaviour should be prevented even though this may seem unfriendly or unethical.

The other approach, the "Fogg Behavioural Model", improved understanding of the behaviour change process by mapping the relationship between motivation and ability and at what point behavioural triggers can be effective for persuasive design (Figure 7). "The model asserts that for a target behaviour to happen, a person must have sufficient motivation, sufficient ability (simplicity), and an effective trigger" (Fogg, 2009). Fogg enhanced his behaviour model and changed the term "trigger" to "prompt"; however, the concept of prompt can be a cue, a trigger, a call to action, a request and so forth (Fogg, 2018). There are three types of prompts: facilitator, signal and spark. A prompt tells people to perform the behaviour now. The major factor, which is "motivation" in the vertical axis (Figure 7), highlighted three core motivators that have two sides:

(1) Sensation (pleasure/pain)

(2) Anticipation (hope/fear)

(3) Belonging (social acceptance/rejection)

The next major factor is "ability" in the horizontal axis. The term "simplicity" is also used to emphasize focusing on the simplicity of the target behaviour increases ability (Fogg, 2018). Simplicity has six parts: time, money, physical effort, brain cycles, social deviance, and non-

routine. Mainly, if performing a target behaviour takes time, this means that it is hard to think, requires physical effort, is against the norms or is out of routine, may not be simple for people. Mainly, two aspects are seen summarized in Fogg's model: motivation and ability. Guiding, encouraging, persuading and understanding the interaction are the other keywords seen in various approaches. In other research in the field, these terms can be replaced by relative terms, categories, strategies or lenses.

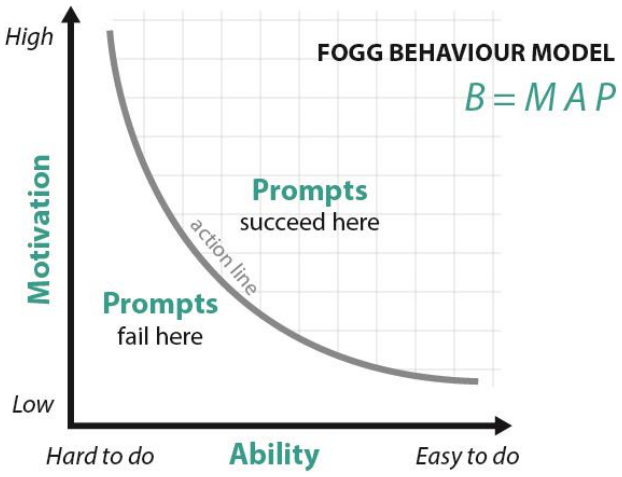


Figure 7. Fogg's Behaviour Model (adapted from Fogg, 2018)

These following approaches are reviewed in detail since they are one of the core studies widely accepted and enhanced by those working in the same field of research. Another brief overview was later illustrated by Daae and Boks (2017) that highlights the different ways of achieving target behaviour that can be clustered by the dimension of distribution of "control". Daae and Boks' (2017) mapping that can be seen in Figure 8 clearly demonstrates the link of behaviour change models and how different authors focus on different and similar aspects simultaneously. Their work illustrates the significant amount of attention that has been given to understanding how design may affect behaviour; however, it is still vague which strategies are the most appropriate to apply (Daae & Boks, 2014, p. 147). Therefore, they have expanded the work on their "Principles of Behaviour Change Tool" and explored the dimensions that designers can use to affect user behaviour in the desired way. Although all dimensions of behaviour change that they have categorized are claimed as important, "control" and "obtrusiveness" dimensions are scored as the most important ones.

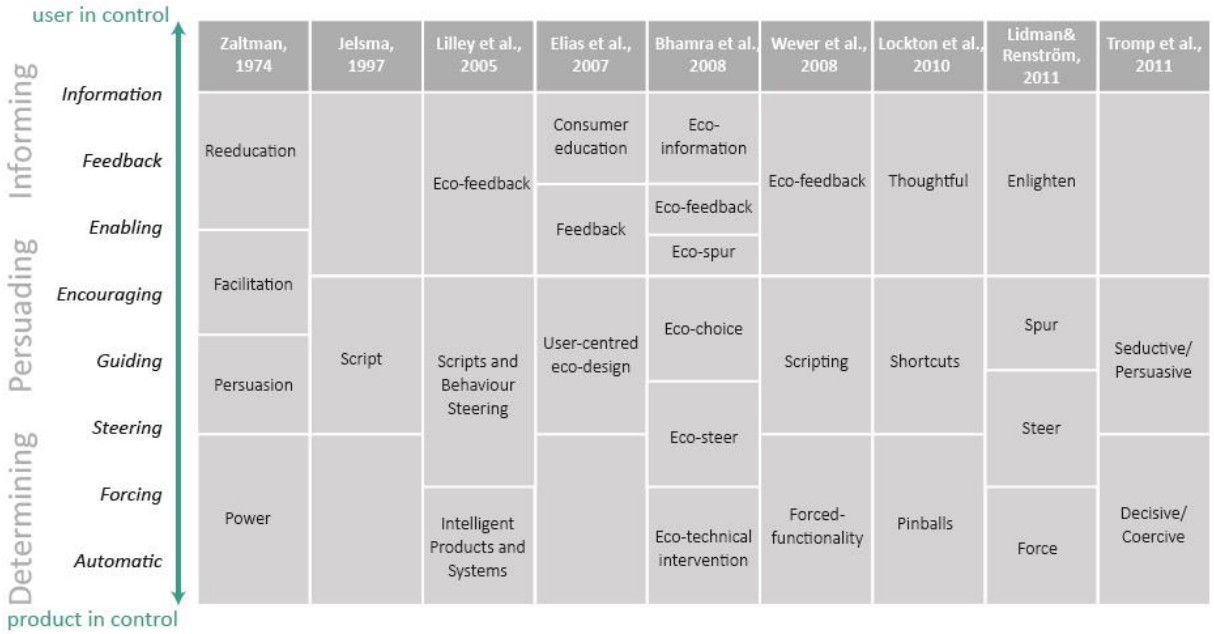


Figure 8. Distribution of change strategies (adapted from Daae & Boks, 2017)

"Control" dimension of behaviour change card that was created by Daae and Boks (2017) shows a brief summary of behaviour change strategies (Figure 9). Most approaches developed are centred around the basic principles that were located on the control scale. This "control" dimension is explained as in the following:

> *How much control the user has over the behaviour can vary from complete control to no control. If the user has much control, designers can only expect the user to behave the desired way if this is in line with their intentions. Having more control is often easier to accept for users, but will generally require more attention, and willingness to pay that amount of attention* (Daae & Boks, 2017).

In this sense, approaches such as providing feedback, increasing user motivation, or helping users create goals for desired behaviour make "user in control". This might make users understand and feel empowered. Approaches such as forcing users, disabling undesired functions or punishing for the undesired behaviour make "product in control". This can also change behaviour for all users, not only for the ones that has a particular demand or need. Of course, both opposite directions "user in control" and "product in control" may have negative outcomes. These approaches, strategies or dimensions are useful depending on the situation, product or target behaviour. It is still hard to decide which strategy might fit best for the target behaviour or if it is ethical to persuade someone who does not consent to be persuaded. However, Daae and Boks' (2017) study concludes that if global sustainability's ethical goals are in sight, designers can decide which dimension or strategies to choose.

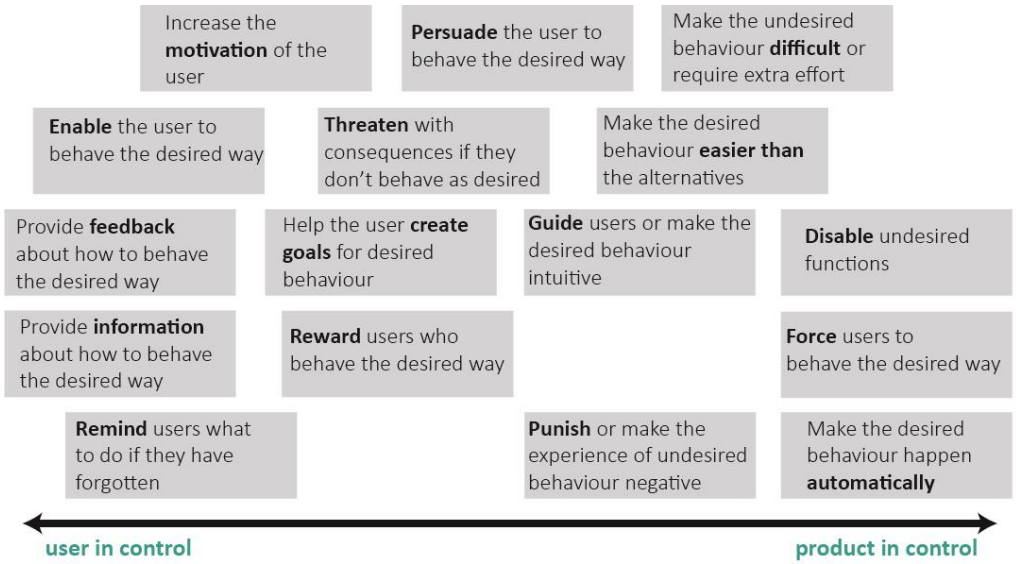


Figure 9. Dimensions of behaviour change card "control" (adapted from Daae & Boks, 2017)

1.2 Smart Cities

United Nations (2017) estimates that between 2017 and 2030, the world population will increase by 7.5 to 8.5 billion inhabitants. By 2100, it is predicted to increase further to 11 billion inhabitants. Over the past century, the balance of population has shifted from the countryside, and nearly half of the world's population lives in cities due to industrialization. By 2030, urban areas are projected to house 60% of people globally, and one in every three people will live in cities with at least half a million inhabitants (United Nations, Economic & Social Affairs, 2016).

There are some similar studies and reports related to the reason for urbanization and increasing population towards cities. Eremia, Toma, and Sanduleac (2017) addresses this need for urbanization as "hope for a better life" such as jobs, education, medical care, etc. Likewise, Etezadzadeh (2016) answer the question "What do people expect when they move to a city?" as "hope to gain access". She claims that people have one element in common: access. It might be access to jobs; access to necessities of life such as water, food, housing; access to information, knowledge and technological advances; access to other people, a social, cultural or religious life; access to a place like courts and other opportunities (Etezadzadeh, 2016).

Ultimately, cities offer a good quality of life to their citizens, which motivates people to be part of it. As the planet becomes more urban, people need to deal with much more complexity

in urban life, such as overpopulation, pollution, poor infrastructure, depletion of sources, and so forth. Urban development has increased, making sustainability an important factor (Sujata, Saksham, Tanvi, & Shreya, 2016). Considering exponentially advancing information and communication technologies, cities are increasingly aware of the "smart city" concept and developing strategies to deal with the "complexity". In this sense, "smart" refers to technological and inter-connected, but also sustainable, comfortable, safe (Sanseverino, 2014), briefly liveable and efficient (Sujata, et al, 2016). Although the "smart city" concept is still under development and various studies suggest different terms related to smartness and cities' future (Eremia, et al., 2017), the engagement of technology and sustainability is considerably important.

Before exploring the terminology, it is vital to be clear about common goals that emerge from different city focus types (i.e. smart, digital, healthy, sustainable, future,...). These shared goals are stated as (Etezadzadeh, 2016, p. 8):

1. *Protecting the natural environment, the climate, and resources*
2. *Maintaining the urbanities' quality of life or promoting the social development of the city*
3. *Maintaining the city's competitiveness or promoting its economic development,*
4. *... for current and future generations*

1.2.1 Smart City Concept and Related Approaches

The idea of a smart city is still evolving, and the concept is comprehensive, shaped by a complex mix of technology, social, economic, and environmental factors (European Parliament, 2014). There is a considerable overlap of the smart city concept with other related city concepts such as intelligent city, sustainable city, digital city, eco-city, future city, and so forth. However, smart city has become predominant among these variants (European Parliament, 2014, p. 22), which is also seen in the definitions of the term that encompasses related concepts. On the other hand, in the literature we can find various definitions of smart city (Albino, Berardi, & Dangelico, 2015, pp. 6-8) as is the case of the following examples:

> *A city well performing in a forward-looking way in these six characteristics (economy, people, governance, mobility, environment, and living), built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens* (Giffinger, et al., 2007).
>
> *Being a smart city means using all available technology and resources in an intelligent and coordinated manner to that are at once integrated, habitable, and sustainable* (Manuel Barrionuevo, Berrone, & Ricart, 2012).

A city seeking to address public issues via ICT-based (Information and Communication Technology-based) solutions on the basis of a multistakeholder, municipally based partnership (European Parliament, 2014).

Giffinger, et al. (2007) propose six characteristics of a smart city that focus not only on digital data and information but also on other dimensions. These characteristics are essential to better understand the concept since many studies are based on this classification (e.g. (Adamuscin, Golej, & Panik, 2016; Rucinska & Knezova, 2014; Sujata, Saksham, Tanvi, & Shreya, 2016; European Parliament, 2014). According to the classification, these six characteristics are smart economy, smart people, smart governance, smart mobility, smart environment and smart living (Figure 10), which are built on the "smart" combination of endowments and activities of self-decisive, independent and aware citizens. "Smart Economy" includes the factors all around economic competitiveness such as innovation and productivity. "Smart People" emphasizes the education quality as well as social interactions and openness towards the world. Participation in decision-making, functioning and transparent services are highlighted under the "Smart Governance". Local and international accessibility, sustainable transport systems are also stated under "Smart Mobility". "Smart Environment" is described as various issues related to environmental protection, and "Smart Living" involves the quality of life concerns, including cultural activities, well-being, safety and housing. To sum, Giffinger, et al. (2007) states that the fields of activities that take place in the urban context as seen in the characteristics. "Accessibility", "quality", and "awareness" are also keywords that highlight other relevant factors. However, we should bear in mind that these keywords are drawn in the concept of sustainable development as well. Thus, to define the smart city concept in the scope of this study, not only must all these characteristics and factors be fulfilled, but also the sustainability concept must be kept at the forefront.

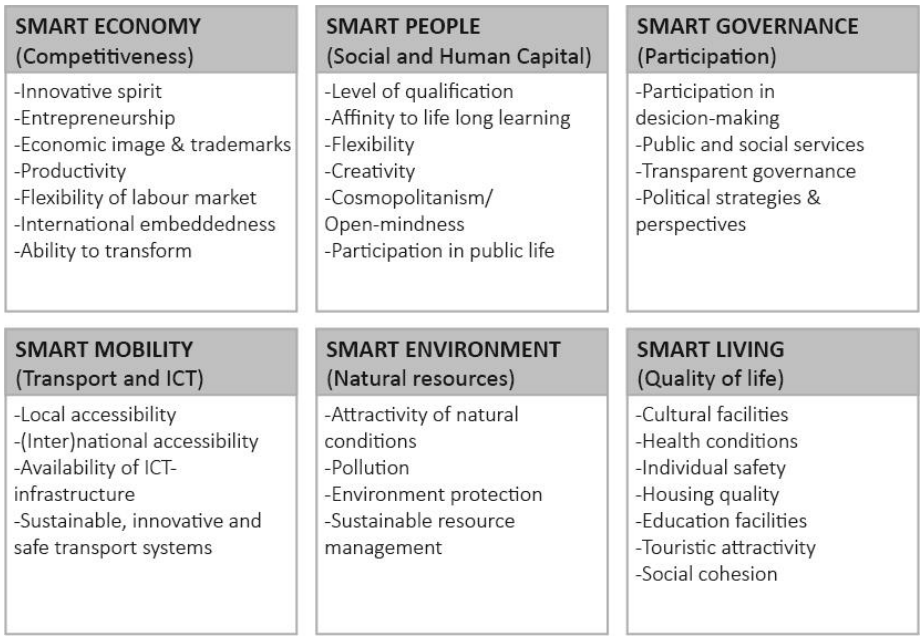


Figure 10. Characteristics and factors of smart city (adapted from Giffinger, et al., 2007)

In literature, we can find recent studies focused on actively developing strategies of cities towards the goal of becoming "smart". For instance, Sujata, et al. (2016) proposed six significant pillars, which are known as the SMELTS Framework: Social, Management, Economic, Legal, Technology and Sustainability (Figure 11), considered crucial for understanding and developing smart cities. According to this approach, smart cities initiatives should be sensitive in terms of balancing the need of communities and projects of smart cities must have an "impact on the quality of life of citizens and aim to foster more aware, educated and informed citizens" (Sujata, et al., 2016, p. 904), which is considered in the "Social" factor. Participating in the governance and management of the city is also considered in this pillar. "Management" factor focuses on the effective and efficient administration of smart cities that rely on implementing smart governance infrastructures such as collaboration, data exchange, equality and transparency. "Economy" is considered as one of the major drivers as a key to measuring growing city competition. Entrepreneurship, productivity and innovation are included in this factor. Since rules and regulations must be considered before taking decisions, the "Legal" factor is also highlighted while implementing and managing smart city drive. Another significant role is "Technology" since smartness is due to the rapid evolution of technology. "Sustainability" is also highlighted to diminish the impact of cities, provide good quality of life, and give importance to future needs. All these factors affect each other, and the outer level factors are addressed as they might get influenced by the inner level before impacting the smart city initiatives (Sujata et al., 2016).

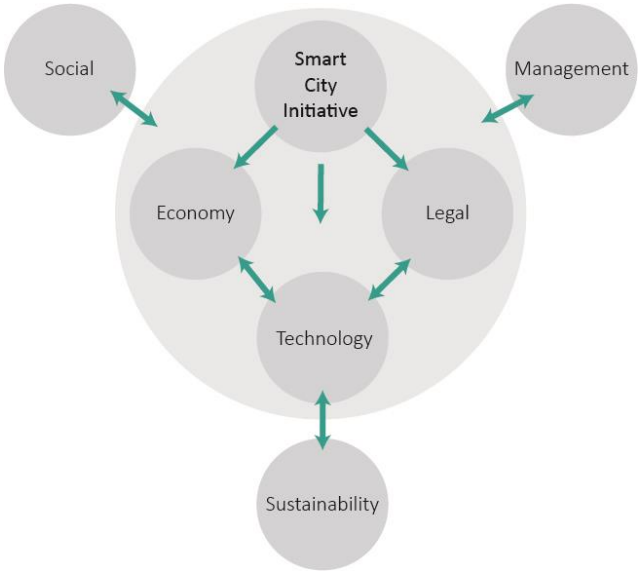


Figure 11. SMELTS Framework for smart city initiative (adapted from Sujata et al., 2016)

The terminology used over time suggests various terms related to smartness and the future of cities (Figure 12). Even only from the technology perspective, terms such as digital city, intelligent city, virtual city, ubiquitous city are suggested (Albino, Berardi, & Dangelico, 2015). Despite the overlaps, the "smart city" concept has become predominant among these variants (European Parliament, 2014) and discovered as the most used term together with "sustainable city" in the literature (Eremia, Toma, & Sanduleac, 2017). As seen in the previous approaches, the sustainability and smartness of the cities are integrated with each other. Moreover, the smart city encompasses and supports the elements of sustainability, including social, environmental and economic aspects of it, simultaneously suits the evolution of the new internet technologies (Eremia, Toma, & Sanduleac, 2017).

Domain	Social	Economic	Governing
•Garden cities •Sustainable cities •Eco-cities •Green cities •Compact cities •Smart cities •Resilient cities	•Participative cities •Walkable cities •Integrated cities •Inclusive cities •Just cities •Open cities •Livable cities	•Entrepreneurial cities •Competitive cities •Productive cities •Innovative cities •Business-friendly cities •Global cities •Resilient cities	•Managed cities •Intelligent cities •Productive cities •Efficient cities •Well-run, well-led cities •Smart cities •Future cities

Figure 12. Part of the terminology used over time (adapted from Eremia, Toma, & Sanduleac, 2017)

The smart city is not just about a few enthusiasts but all citizens (Sujata, et al., 2016). It is about daily chores, everyday life and altering attitude since it encompasses social and sustainable factors. Eremia, et al. (2017) also defines smart city by sustainable development indicators of communities to ensure urban services and the quality of life such as energy, environment, health, safety, shelter, solid waste, telecommunications and innovation, transportation, urban planning, waste water and so forth. Regarding these dimensions, the smartness of the city is created by interconnecting digital networks and integrating them into systems, sensors and sensorial organs, as well as software tools (Eremia, et al., 2017). In this matter, the Internet of Things (IoT) concept cause easier use of databases and software applications for more efficient cities and providing a better quality of life for citizens.

1.2.2 Smart City and Internet of Things (IoT)

The term Internet of Things (IoT) was first coined by Kevin Ashton, the technology pioneer who cofounded the Auto-ID Labs at MIT in the 1990s and has recently received great attention (Kramp, van Kranenburg, & Lange, 2013). IoT transforms everyday physical objects in the surrounding environment into ecosystems of information that enrich people's lives (Vermesan, et al., 2017). Simple machines and objects are now embedded with sensors and actuators with the ability to communicate over the Internet and collectively form the IoT (ETSI, 2018).

The actualization of the IoT concept demands various enabling technologies such as identification, sensing and communication technologies. The key components are Radio Frequency Identification (RFID) systems and Wireless Sensor Networks (WSN) (Atzori, Iera, & Morabito, 2010; Gubbi, Buyya, Marusic, & Palaniswami, 2013). RFID systems can be used to monitor objects in real-time that allows for mapping the real world into the virtual world. They basically help automatic identification of anything they are attached to and used in many applications in retail, supply chain management, transportation, bank cards, e-health and more (Atzori, Iera, & Morabito, 2010; Gubbi, Buyya, Marusic, & Palaniswami, 2013). WSN are networks of dedicated sensors that monitor and measure physical conditions of the environment such as temperature, sound, pollution levels, humidity and wind (Ullo & Sinha, 2020). IoT technologies and applications are driving digital transformation by gathering an enormous amount of data and creating the next generation of smart buildings, smart vehicles and other smart objects by providing intelligent automation, predictive analytics and proactive

intervention (Vermesan, et al., 2017). Artificial Intelligence (AI) or advanced Machine Learning (ML) is also integrated into IoT systems which means that these next-generation smart objects can understand, learn, predict, adapt and operate autonomously (Vermesan, et al., 2017).

This new technology development is recognized as one of the critical areas of future technology from a wide range of industries (Lee & Lee, 2015). Several reports demonstrate that companies across various industries have IoT on their radar and the market spend is growing largely focus on the following key areas: smart communities/smart cities, energy/utilities, agriculture, transportation, healthcare and home monitoring (Verizon, 2016; Rose, Eldridge, & Chapin, 2015). Atzori, et al. (2010) also highlights the potentialities of this technology to improve the quality of our lives in the following domains: (1) Transportation and logistics, (2) Healthcare, (3) Smart environment (home, office, plant), (4) Personal and social life. These are defined as "realistic" and distinguished from another domain clustered as "futuristic". Atzori, et al. (2010) explains why they rely on some technologies that either are still to come or whose implementation is still too complex. Appealing applications are mapped in Atzori et al.'s (2010) research (Figure 13) and is clear that most applications of this technology occur in the context of city life, especially related to transportation/mobility.

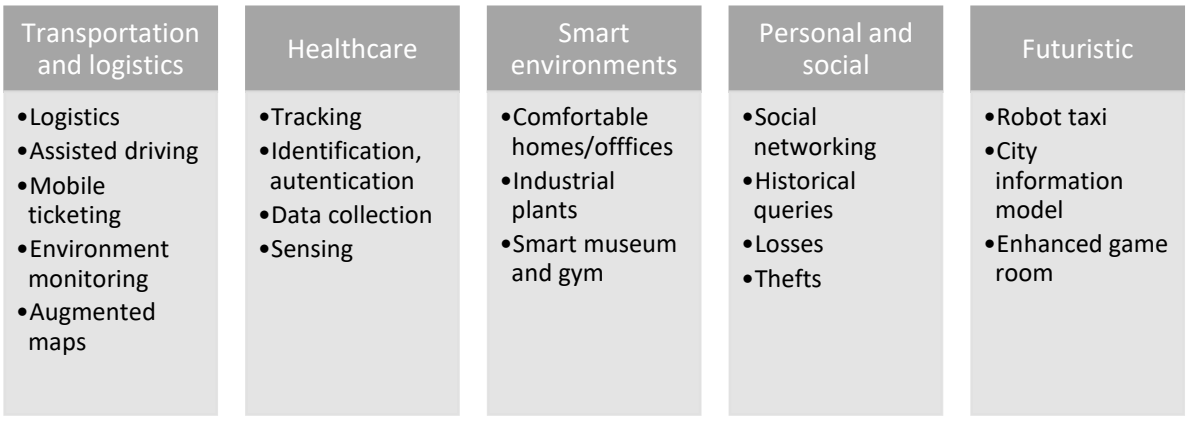


Figure 13. Applications domains and relevant major scenarios (adapted from Atzori, Iera, & Morabito, 2010)

The incorporation of IoT and smart cities play an essential role in developing future cities and communities (Eremia, Toma, & Sanduleac, 2017) and ensuring sustainable development (Sujata, Saksham, Tanvi, & Shreya, 2016). IoT has been anticipated to be an integral part of urban spaces in the home and industry, geriatric care, medical assistance, smart grids, traffic management, and energy management, among others (Tiwari, 2017; Bellavista, Cardone, Corradi, & Foschini, 2013).

Tiwari (2017) argues that research and development of IoT system applications for smart cities are still in progress and also labels IoT as:

> *"sensing" gadgets that are wearable (by individuals), movable (installed in vehicles, smartphones, and personal data assistance devices), or static (fixed in houses, power grids, green and open spaces, streets, traffic lights, and other places), and connected to the Internet to generate big data for sustainable smart city operations, mostly in real time.*

Seuwou, et al. (2020) claims that it is beyond doubt that the transportation system will be transformed and revolutionized with the integration of these evolving technologies. They will be introduced at all stages of systems in city life, including vehicles, traffic lights, or delivery services around the city. This transformation will collect and provide important information and create opportunities for individuals (Seuwou, Banissi, & Ubakanma, 2020).

IoT opportunities for city life are mostly seen in the mobility scenarios of the future cities in multiple reports and trend foresight (Fishman, 2012; Hannon, McKerracher, Orlandi, & Ramkumar, 2016; Giffi, Littmann, Westcott, & Scmith, 2019). The previous sections of this document, we highlighted that the most critical reason for urbanization was "hoping to gain access". This might explain the tendency to focus on mobility scenarios since mobility is one of the main characteristics of smart cities, which is the core of accessing any kind of necessity. Plus, congestion is becoming a bigger problem and creating an unsatisfactory experience and wasteful for people and the environment (Fishman, 2012). New possibilities and opportunities of digital-age technology are foreseen to promote new modes of transport and connected services together in innovative new ways. Fishman (2012) defines it as next-generation urban transport systems (Figure 14). On this basis, we can assume that smart future mobility with IoT technology has a real potential to reshape the ways people move around in city life. In this sense, focusing on next-generation modes of mobility in a smart environment is an essential endeavour.

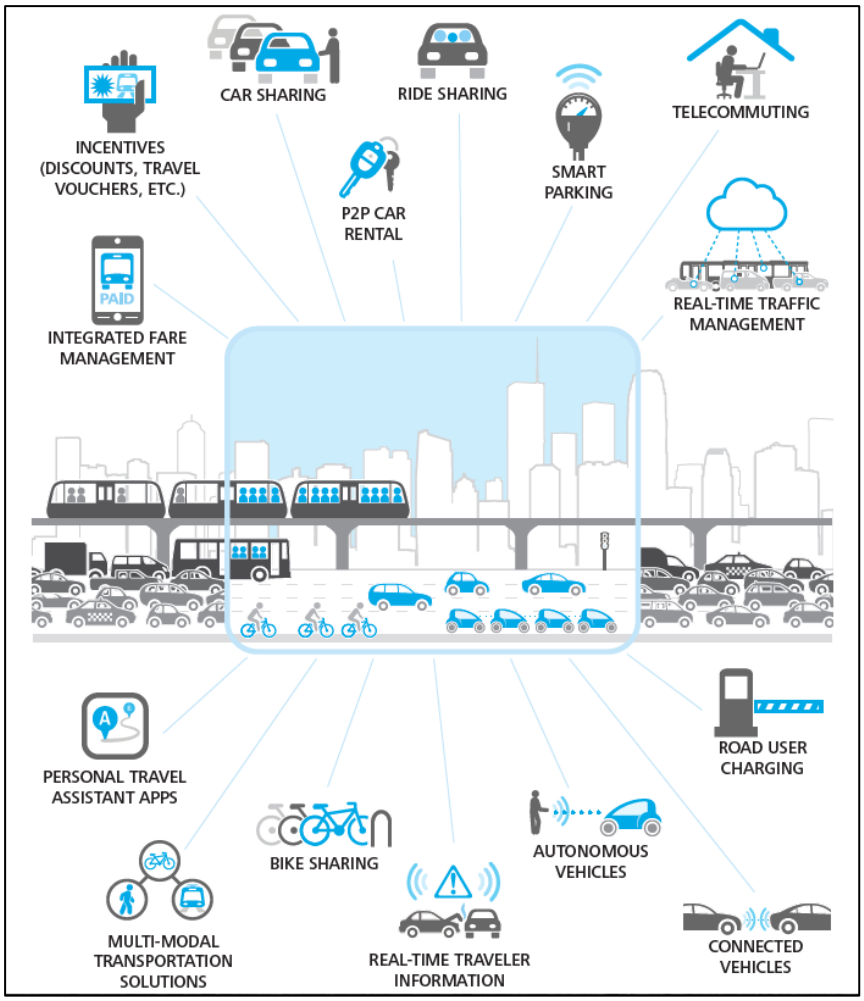


Figure 14. Next-generation urban transport systems (Fishman, 2012)

IoT concept and digital technologies have various potential to reshape how people move around the city, promote smart cities, and have undeniable benefits. However, it also raises ethical concerns such as privacy, data usage, trustworthiness, dominating personal life, and reshaping human behaviour unfavorably. Since there would be great dependability on the technology industry, it is becoming introspective, examining its own ethical principles, and exploring how to better manage its size and authority (Silverglate, Kosmowski, Horn, & Jarvis, 2021).

1.2.3 Smart Mobility and Sustainability

As stated in the previous parts, various studies focus on promoting sustainable behaviours in the context of "lifestyle" or "everyday life". In the example of Manzini and Jegou's (2003) project, some urban life scenarios were proposed to contribute to sustainable lifestyles. Before creating the scenarios, one of the main questions asked in the "Cities" topic was "How do you

move around the city?". Similarly, UNEP's (2011) project offers solutions and sustainable ideas related to "mobility", have described mobility as "getting around, getting out" and these expressions were used to question citizens around the world. Another description for mobility term is "the ability to move or be moved freely and easily" (Oxford Dictionaries, n.d.). Having a clear understanding of what the concept of mobility means is important to understanding the idea of "smart mobility". How might this "movement of people" be smart is the central question in the field of smart mobility.

Modern cities require new and distinctive codes that consider sustainability issues while considering new parameters to reach the desired urban smartness (Sanseverino, 2014). In this matter, urban mobility is becoming increasingly important since it is one of the crucial pillars of the smart city concept. As mentioned before, due to Giffinger, et al.'s (2007) approach, smart mobility is one of the six characteristics that emphasize the accessibility of citizens, sustainable and innovative transportation systems and efficient infrastructure of Internet and Communication Technologies. Likewise, Sansaverino (2014) addresses smart mobility as one of the three key features of smart city. The other two are stated as smart governance and smart energy. The importance of mobility is explained by its direct and local impact on the quality of air and quality of life in terms of generating congestion, pollution and preventing freedom of accessibility.

Various research support the importance of mobility such as UNEP (2011) that specifies the significant areas of sustainable lifestyles are mobility, food and housekeeping. It is argued to have great impacts on the environment and society and need to be examined closely. Likewise, Lyons (2018, p. 4) supports that mobility – notably, the movement of people (e.g. commuters) is "an important component of the urban metabolism". Hessel (2015) emphasizes the smartness of mobility and addresses smart mobility as a tool to achieve sustainable cities.

Sanseverino (2014, p. 9) defines smart mobility as:

1. *The ability to guarantee a good availability of public, innovative and sustainable transportation services;*
2. *The support of low environmental impact transportation means such as bikes or pedestrian routes;*
3. *Ruling the access to historical centres;*
4. *The adoption of advanced solutions for mobility management through info-mobility, managing the mobility of individuals within the city and towards the neighbouring areas.*

Lyons' (2018, p. 7) prefers to use the term "smart urban mobility" and summarises it follow:

1. *Using technology to generate and share data, information and knowledge that influences decisions;*
2. *Using technology to enhance vehicles, infrastructure and services; and*
3. *Deriving improvements for transport system operators and users and shareholders*

Additionally, Lyons (2018, p. 9) proposes the definition of smart urban mobility as "connectivity in towns and cities that is affordable, effective, attractive and sustainable". Regarding this definition, "connectivity" acknowledges physical mobility of people and goods is only one means of providing access but not only considers motor vehicles. Being "affordable" and "effective" for users involves understanding the differing needs and abilities in cognitive, physical, and financial terms concerning connectivity. The definition also asserts concerns related to being "attractive" for everyone. Mobility systems must meet the needs of individuals as citizens, urban dwellers or business owners. Finally, achieving all these requirements must have a long-term basis that emphasises the "sustainable" determinant of the term.

1.2.3.1 Smart and Sustainable Modes of Mobility

Mobility is recognized as one of the most important elements to support the functioning of the area for a better quality of life. A shift with the possibilities of technology will encourage the increase of smart mobility services with more efficient vehicles, renewable energy, innovation and optimization of cities resource allocation with intelligent systems (Seuwou, Banissi, & Ubakanma, 2020). Nevertheless, different modes of urban mobility (e.g. personal cars, taxi, on-demand transport) cause negative impacts and problems for people and the environment. Smart mobility with IoT and other emerging technologies is seen as a high potential to eliminate these destructive issues. Seuwou, et al. (2020) summarizes the most important smart mobility objectives in six categories: (1) Reducing pollution, (2) Reducing traffic congestion, (3) Increasing people safety, (4) Reducing noise pollution, (5) Improving transfer speed (6) Reducing transfer costs. Based on these objectives, we can argue that smart mobility committed to contributing to sustainability. Moreover, sustainable mobility will benefit greatly from being "smarter". These terms should no longer be considered independent.

Different approaches ensure smart and sustainable cities in the future, as well as diverse suggestions regarding specific modes of mobility or improvements. Perschon (2012) recommends potential strategy responses for sustainable mobility as avoiding, shifting and improving particular transport types (no travel, non-motorised, public-motorised and

individual motorized) (Figure 15). This approach emerged with the objectives of avoiding unnecessary traffic and shortening journeys, ensuring that bus, rail travel and cycling become competitive alternatives to the private car, and reducing overall traffic volume.

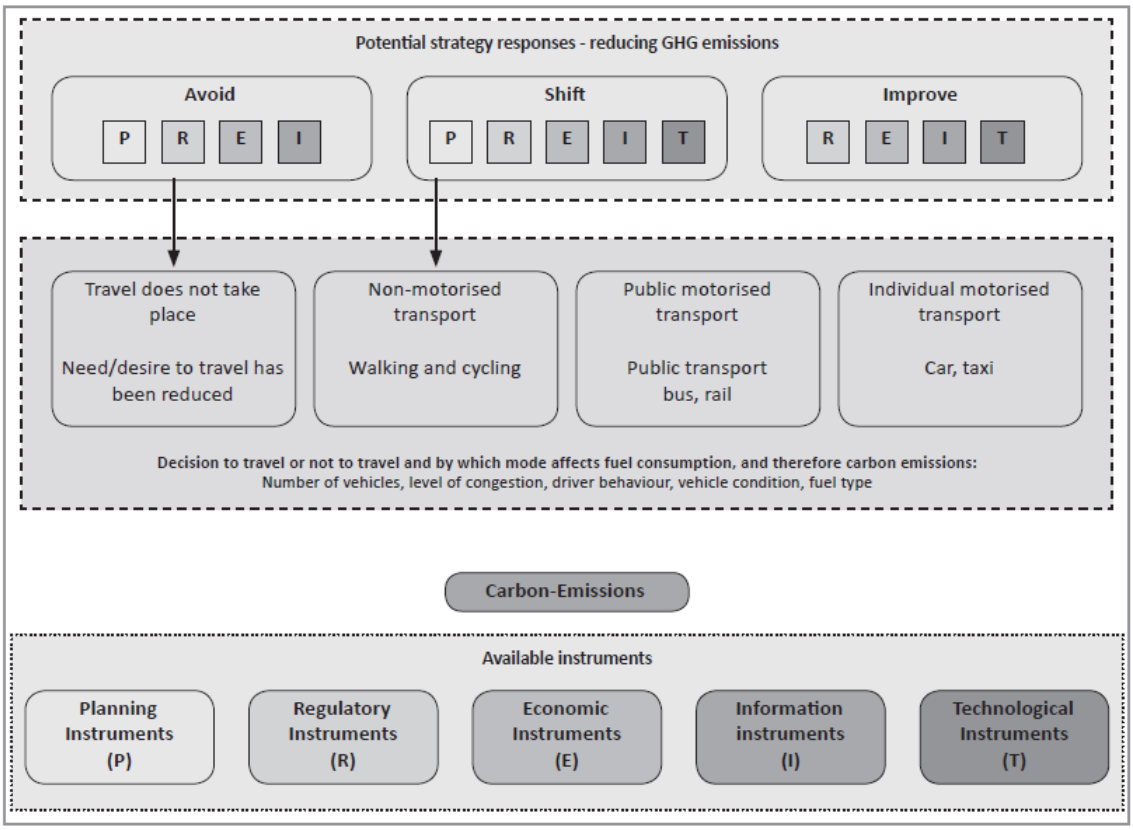


Figure 15. Avoid-Shift-Improve Model (Perschon, 2012, p. 7)

Vermesan, et al. (2017) claims that consumer preferences, technological breakthroughs add up to a fundamental shift in individual mobility behaviour. Individuals increasingly use multiple modes of transportation to complete their journey, and this cause priority on on-demand mobility solutions (Vermesan, et al., 2017). On-demand mobility services allow ordinary motorists to use their personal car to offer prearranged transportation services enabled via mobile phone and making the taxi market more competitive (Viechnicki, Khuperkar, Fishman, & Eggers, 2015). Other studies highlight the emerging research on autonomous vehicles that will automatically recognize individuals, their needs when they enter and work as a new form of on-demand transport (Giffi, Littmann, Westcott, & Scmith, 2019; Vermesan, et al., 2017; Seuwou, Banissi, & Ubakanma, 2020).

Viechnicki, et al. (2015) proposes another mobility approach for reducing congestion, better air quality and a smaller urban footprint for parking. They focus on four modes of alternative mobility and traditional ones (e.g., buses) as a future model designed around individual

mobility. These are identified as ride-sharing (or carpooling), bike commuting, car-sharing, and on-demand ride services (Table 6). They are suggested as being faster, greener and cheaper transportation options for smart mobility ecosystems.

Table 6. Four modes of alternative mobility (adapted from Viechnicki, Khuperkar, Fishman, & Eggers, 2015)

Modes of Mobility	**Content**
Ride-sharing (including carpooling, vanpooling, real-time or "dynamic" ride-sharing services)	Classic: Two or more travelers sharing common, pre-planned trips made by private cars or vans. Recently: A dynamic service that can match drivers with riders in real-time without advance planning.
Bike commuting	Trips made to work by bicycle.
Car-sharing (round trip, one-way, and personal vehicle sharing)	Providers (such as car2go, Zipcar, DriveNow) and private individuals rent out their vehicles through peer-to-peer car-sharing programs.
On-demand ride services (ride-sourcing or ride-hailing services)	Online platforms developed by transportation network companies (such as Uber, Lyft, SideCar) allow passengers to source or hail rides from a pool of drivers that use their personal vehicles.

In general, the literature converges on the idea that to have sustainable and intelligent scenarios it will be necessary to improve or change different modes of mobility. There is also a broad consensus that we need to decrease the usage of personal cars and that can be achieve in various ways, such as preferring shared forms, encouraging other mobility types, or changing into ecological fuel and more secure versions (e.g. autonomous vehicles). European Platform on Sustainable Urban Mobility Planning (Rupprecht Consult - Forschung&Beratung GmbH, 2019) developed research for creating guidelines and they found out that most of the investments had been done in the last five years on private cars as well as public transport. According to them, the priority should be shifting into other transport modes such as walking and cycling (Figure 16).

Transport modes	Priority	Investments the last year	Investments the last five years
Walking		100	800
Cycling		200	1300
Public Transport		5000	19000
Taxi / transport (e.g. special transport services)		200	1000
Car-sharing		100	200
Car		2000	15700
Total		7600	38000

Targets	Priority	Investments the last year	Investments the last five years
Improve safety & security		1000	4000
Increase walking & cycling		200	1300
Increase quality & use of public transport		5000	19000
Effective freight system		1000	3000
Accessibility private cars		2000	15700
Total		9200	43000

Figure 16. City's priorities of transport modes and targets (adapted from Rupprecht Consult - Forschung&Beratung GmbH, 2019)

1.3 Fashionable Technology

This section provides an overview of the relation between fashion, technology and sustainability and offers an insight about different definitions and critical characteristics of fashionable wearables.

The term "fashionable technology" was first used in 2000, meaning "the intersection of design, fashion, science, and technology" (Seymour, 2009) that contains fashionable wearables and embedded technologies. Seymour (2009) defines fashionable wearables as "designed" garments, accessories, or jewellery that combine aesthetics and style with functional technology. Embedded technologies influence the wearability, comfort and aesthetics of a fashionable wearable. Incorporating technology depends on the context of use, the objectives and the desired interaction between the fashionable wearable and its surrounding environment. Fashionable technology is associated with various disciplines in design and technology that frequently intersect (Figure 17). This intersection is mainly seen in wearable computing, as Seymour (2010) highlights while proposing the timeline of fashionable technology. Most of the examples which may be entered in this category of artefacts are also called wearables or wearable computers in the field of wearable technology (Malmivaara, 2009).

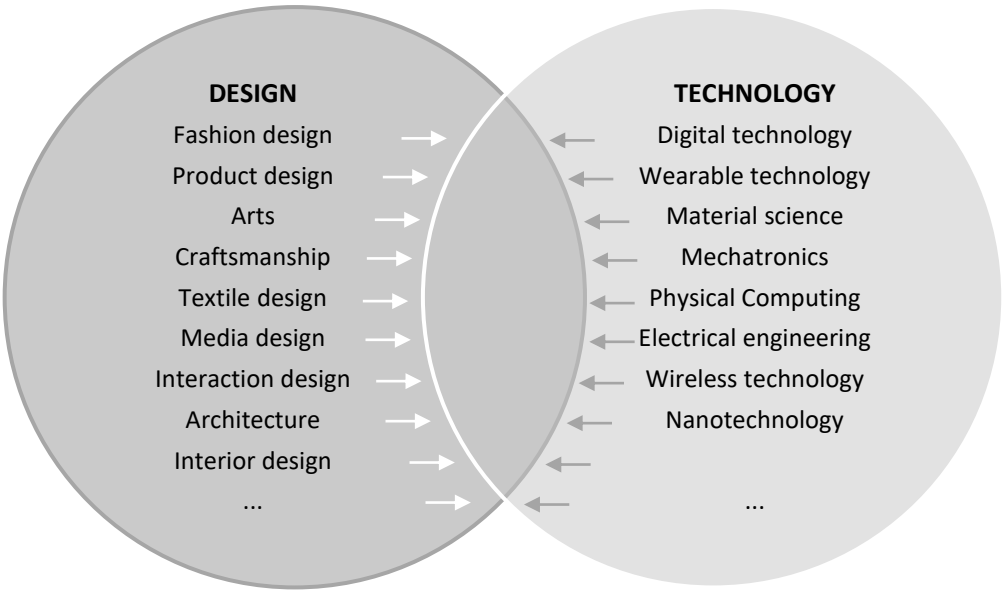


Figure 17. The intersection of design and technology in the term "Fashionable Technology" (adapted from Seymour, 2010)

The term wearable technology refers particularly to computer technologies and electrical engineering (Seymour, 2009) rather than fashion design's aesthetics and style dimensions. This study adopts Seymour´s terminology, using "fashionable technology" term as an umbrella that refers to all and the "fashionable wearables" term that refers to the smart fashion products. Since the history of wearable computing and fashionable technology appears to be strongly intertwined, the field of wearable technology should also be clarified.

1.3.1 Wearables and Wearable Technology

Wearable technology or wearable computing refers to different forms of electronic and computing devices that can be directly worn or carried on the body and perform functions such as collecting data, track activities, responding to users' needs and desires (Thierer, 2015; Malmivaara, 2009; Hanuska, et al., 2016). On the other hand, wearables are defined as integrating key technologies into intelligent systems to bring new functionalities into clothes, fabrics, patches, watches, and other body-mounted devices (Vermesan, et al., 2017). Therefore, wearables are intelligent devices that incorporate nanoelectronics, sensory, communication, computation technologies, visualization, embedded software. These key technologies and forms of electronic and computing devices are titled wearable technologies. Although the terms "wearable technology", "wearable devices", and "wearables" all refer to items of clothing or accessories with embedded technology (Tehrani & Michael, 2014).

Hanuska, et al. (2016) claims that in the 1970s, to define wearables, there must be two main criteria: comfortably worn on the body for extended periods of time, independently powered and including sensors or microcomputers to process information. After the wearable industry's momentum in the 2000s, wearables started to have "smart" qualities advancing in two areas that are the ability to collect personal data and the ability to provide real-time data insights to users. These advancements, coupled with smartphones' ubiquity, initiated the market for smart, wearable and personal devices.

There are different segments in wearable technology depending on the location of the wearables, types or features of the electronics or sensors, and market places. Figure 18 shows the types of wearables related to the location of the body and the technology. Smart clothing, smart accessories and some other devices like Bluetooth key trackers are also specified. Yole Develeoppement (2014) presents another segmentation, which is called wearable electronics segmentation, which also mentions the location of the wearables (Figure 19). Some parts of the human body are more suitable for particular wearables than others. For instance, helmets and optical products are included in head-wear. Collars and necklace products are for neck-wear, and smart watches, wristbands and rings are included in arm-wear. The arm-wear category is also considered as the most promising market, and we can find many players targeting it. The foot-wear category includes shoes and socks, body-wear includes clothing and other devices monitoring back/spine position.

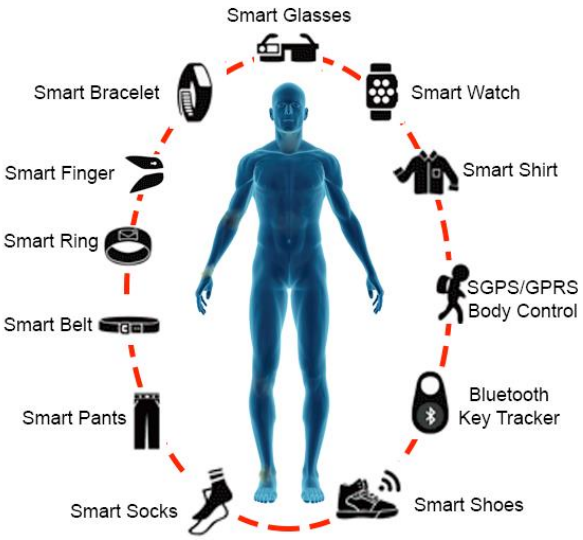


Figure 18. "Different types of wearable technology" (Rodrigues et al., 2018, p. 9)

Figure 19. "Wearable electronics market segmentation" (adapted from Yole Developpement, 2014)

The industry in the wearables market have gravitated to four primary marketplaces (Hanuska, et al., 2016): (1) Infotainment, (2) fitness and wellness, (3) Military and industrial, (4) Health and medical (Table 7). Hurford (2009) also suggests four open areas that can overlap in some places, mainly similar technology being repackaged for different end-use. His segmentation is somewhat similar to Hanuska, et al.'s (2016) one; however, titled differently as (1) Sports, (2) Healthcare, (3) Fashion and entertainment, (4) Military, public and safety. The only difference between both proposals is the association of fashion and entertainment. Designers such as Alexander McQueen, Erina Kasihara, Diana Drew and Hussein Chalayan offer good examples of how to explore the integration of technology into clothing. In these cases, fashion was used as an artistic approach to wearable technology. Since the definition of fashion and fashion relation between clothing and other categories will be discussed in this work, Hanuska et al.'s (2016) recent version of the segmentation is adopted. The infotainment category offers real-time data transmission for entertainment in the form of music, communications with the integration of smartphones control systems promoting the everyday use of technology. The "fitness and wellness" category is related to the monitoring of activity and emotions. This category can be divided into training/professional sports with the use of monitoring technologies, overlapping healthcare and casual sports incorporating entertainment and communication technologies (Hurford, 2009). The "military and industrial" category offers real-time data transmission in the military and industrial environments. Communication and battlefield command systems use a combination of personal, vehicle, static and satellite technologies that all work together (Hurford, 2009). The "healthcare and medical" category has been developing bio-monitoring technologies, to monitor vital signs and sensorial augmentation.

Table 7. Four leading market categories and product offerings (adapted from Hanuska, et al., 2016)

Category	**Product offerings**

Infotainment	Smart glasses Virtual reality goggles Heads-up displays	Smart watches Bluetooth headsets
Fitness and Wellness	Smart clothing Activity monitors Fitness and heart rate Monitors	Pedometers Sleep sensors Smart glasses smart watches Emotional monitors
Military and Industrial	Smart clothing Hand-worn terminals	Heads-up displays Smart glasses
Healthcare and Medical	Smart clothing Biometric monitors Chemical monitors Drug delivery products	Smart glasses Hearing aids Smart watches Defibrillators

1.3.2 "Smart" Focus on Fashionable Wearables and IoT

Products that have digital properties are called "smart" or "intelligent" in the market. In the field of wearable technology, many wearables are defined as smart, as smart glasses, smart watches, smart clothing, etc. Smart systems are typically understood to consist of three parts: a sensor, a processor and an actuator.

> *For example, body temperature monitored by the sensor is transferred to the processor, which on the basis of the received information computes a solution and sends a command to the actuator for temperature regulation. To achieve such interactive reactions three separate parts may actually be needed. The sensor may be embroidered on the surface of the T-shirt by using conductive yarns. Signals are transmitted wirelessly between the processor, sensor and the actuators, which could be microscopic flaps that open in order to increase ventilation and temperature transfer. Or the system may work on the basis of physics like phase change materials* (Matilla, 2006, pp. 1-2).

In this context, smart clothing can be defined as a new garment feature that can provide interactive reactions by sensing signals, processing information, and actuating the responses (Matilla, 2006). Similar terminology such as interactive clothing, intelligent clothing, smart garment, and smart apparel are used interchangeably to refer to this type of clothing. But care must be taken when classifying thing, because, as Malmivaara (2009) says, a jacket with a sewn pocket for a mobile phone does not make a smart garment. Clothing can only be considered "intelligent" if it offers something "traditionally unclothing-like" to the garment, while conserving traditional characteristics such as washability or wearability. Features such as collecting data through a sensor, transferring it to an external computing unit or processing itself are examples of these "non-traditional" functions.

As technology has progressed, new categories of objects were created, including smart phones, smart clothing and wearables. This current tendency of "smartness" in everyday life plays a key role in the IoT concept that represents "a vision in which internet extends into real world-embracing everyday objects" (Mattern & Floerkemeier, 2010). McEwen and Cassimally (2014) summarized components of IoT as an equation of "Physical object + Controller, sensor, and actuators + Internet". Briefly, this "Thing" present in the real world, inside a home or worn around the human body, receives inputs from the environment and transform into reports using the internet. Wearables, which might be considered as the "thing" worn around the human body, and the internet of things relation have given rise to new terms. For example, while some authors prefer to define this technological solution as "Wearable Internet of Things" (Hiremath, Yang, & Mankodiya, 2014), some reports from leading companies prefer to use the term as "Internet of Wearable Things" (Ericsson ConsumerLab, 2016).

The interaction between wearable things is an emerging field of research. A good example of a scenario illustrating this relation of wearables and the IoT context is when your smart watch collects data from activity of yours, body analyser, and smart gym machine collect other data to form a health report (Figure 20). This report directly goes to your health insurer that might offer you free gym membership (Evrythng, 2017).

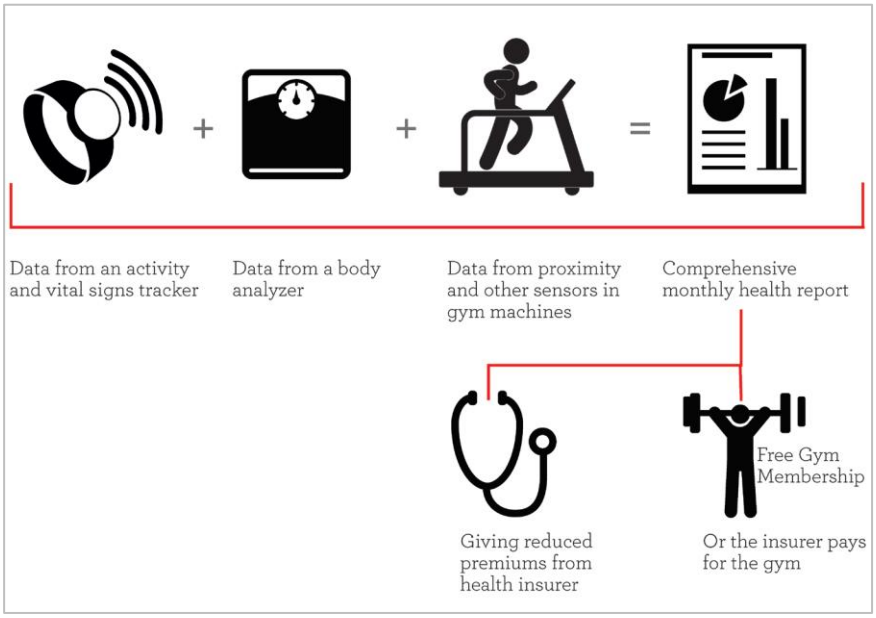


Figure 20. Example of data connections between wearables, other objects/environments (Evrythng, 2017, p. 5)

While the innovations are pushing wearable technology into IoT applications for health care, education, smart cities, smart vehicles, the IoT applications are also expected to benefit from the development of wearable technology with the integration of virtual and augmented reality features (Vermesan, et al., 2017). Forecasts propose that smart devices are expected to include many features and different smart solutions in the following years (Figure 21), and an increasing number of users are interested in using wearables (Ericsson ConsumerLab, 2016).

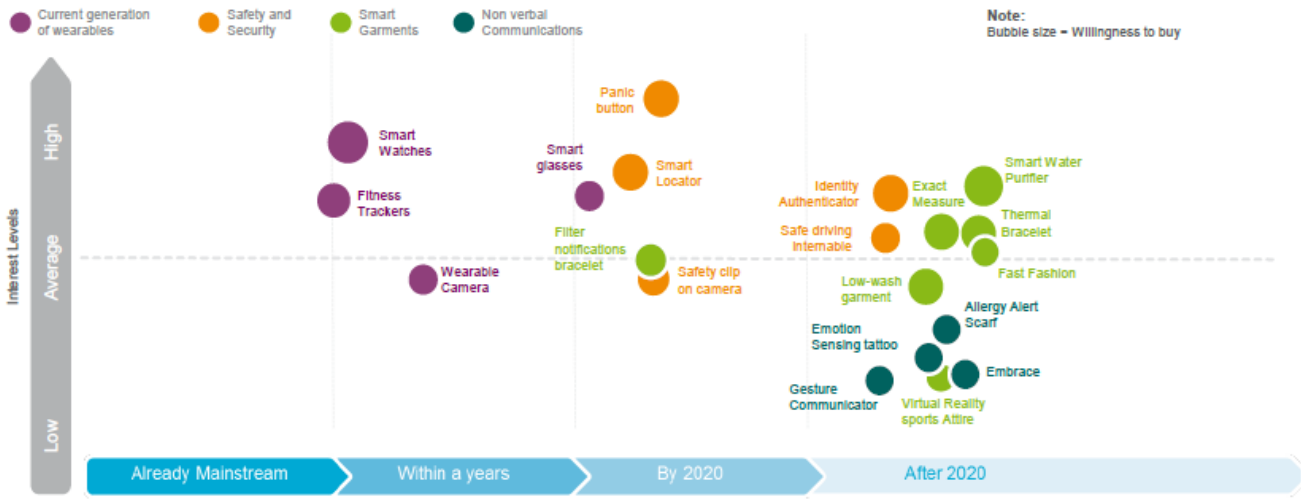


Figure 21. Consumers predict wearable technology inflexion point to be beyond 2020 (Ericsson ConsumerLab, 2016, p. 15)

1.3.3 "Fashion" Focus on Fashionable Wearables

Fashion is a form of desire for pleasure, new experiences, status and identity (Fletcher, 2008), and essential satisfier for individuals because of its characteristics. Fashion refers to the aesthetic, symbolic, emotional, and cultural meanings that objects carry, which people use to express their taste, identity, lifestyle, social status, and participation in a community (Pan, Roedi, Blevis, & Thomas, 2015). Fashionable products are met with users' desires and emotional needs, which are complex, subtle, and inexhaustible (Fletcher, 2008). "Fashionable" expression basically adds the meaning of aesthetic, emotion, human-oriented and identity, wherever it is used before as an adjective. This means that fashion has significant power.

Seymour's (2009) definition for fashionable wearables highlights aesthetics, style and functional technology. However, "fashion" does not only contribute to aesthetics or style as it has various strong meanings. Fashion and art have always had close connections (Ryan, 2008), and there are various debates that fashion is a form of art or not, likewise, whether it is

design or not (Barnard, 2014). Briefly, fashion has art characteristics as performing social, cultural, emotional and aesthetic functions, and again shows design characteristics as performing body-related functions, which makes it practical. Clothing has the purpose of protecting us and keeping our bodies warm and dry. Of course, the definition of "fashion" can be applied to many consumer items such as food, cars, furniture or music, not only the things we wear (Barnard, 2014, p. 16). However, the word fashion is strongly associated with "adornment", "style", "dress", and "clothing" (Polhemus & Procter, 1978, p. 9; Barnard, 2014). Fletcher (2008, p. 120) also argues that "fashion and clothing are different concepts and entities. (...) Not all clothes are fashion clothes, and not all fashion finds expression in garment form. Yet, where the fashion sector and the clothing industry come together (in fashion clothes), our emotional needs are made manifest as garments." The meaning of fashion in the context of clothing also provides physical and functional benefits. Therefore, all the functions and meanings that fashion notion possesses, are equally valuable for the study and it enriches the meaning of the "fashionable wearable" term as well.

Ryan (2008) claims that Thorp's pocket-sized analogue computer developed in 1961, can be considered an early form of wearable technology; however, it was a functional portable gadget that were not actually worn but were carried or held. Therefore, it was out of the body-based nature of wearable technology. In the 1990s, the designer Thierry Mugler's jackets, which were printed like circuit boards, Margaret Orth's methods for stitching electronic circuits directly into the fabric, and Elise Co's designed garments utilizing luminosity, remote activation, and bodily sensors were some of the notable examples for the interaction of fashion and technology (Ryan, 2008). However, Seymour (2010) suggests that initial explorations of Hussein Chalayan, notably the Remote Control Dress in 2000 as a beginning of a potential collaboration between fashion and technology fields. The dress was operated with a remote control that opened the fibreglass panels of the dress to reveal the tulle inside (Seymour, 2009, p. 31). The fashion collection "Before Minus Now Spring/Summer 2000", which contained this iconic dress, focused on the relationship between humans, nature and technology. Later in 2002, Burton designed Analog Clone MD Jacket with an integrated MP3 player. Seymour (2010) claims that this jacket marked the introduction of technology in noticeable consumer products, and after 2010, a new decade of fashionable technology began with various commercial products.

Early examples might be seen as showpieces, conceptual, fantasy or futuristic; however, advances in technology created various fashionable wearables promoting healthcare,

workwear, elderly care and security (Seymour, 2010). Ryan (2008) also addresses wearable technology "has abandoned the dramatic, rock and goth-inspired productions full of cyber disco wear that (…) during the 1990s, and turned to modified runway shows that feature the creativity of individual designers and artists in a vast array of looks, technologies, topics, and associations".

1.3.4 Textile Technology and the Future of Fashionable Wearables

We have explored how advanced technologies, such as the internet and communication technologies, especially IoT technology systems, play a significant role in fashionable wearable design. But we should also look at textile or fabric technology, which also plays a major role in wearable technology (Hurford, 2009, p. 27) since "smart textiles" are the core of fashionable wearables. Hurford (2009) claims that the clothing industry was dramatically changed by introducing nylon and polyester, which are man-made, and this change continues with nanofibres and nano-coatings. These current developments provide many useful and unusual characteristics to fashionable wearables. That is why we call them "smart" as they have the "ability to do many things that traditional fabrics cannot, including communicate, transform, conduct energy, and grow" (Pailes-Friedman, 2016, p. 14). Smart textiles are defined as "textiles that can sense and react to environmental conditions or stimuli, from mechanical, thermal, magnetic, chemical, electrical, or other sources. They can sense and respond to external conditions (stimuli) in a predetermined way" (Syduzzaman, Patwary, Farhana, & Ahmed, 2015).

Smart textiles are the textile version of smart materials, and there are three categories based on their functions: passive, active and very smart materials (Pailes-Friedman, 2016). Passive smart materials gather information and demonstrate it, such as colour change, thermal or electrical resistivity. Anti-microbial, anti-odour, anti-static and bulletproof fabrics are also made of these smart materials. Active smart materials have chameleonic, water-resistant, vapour-permeable, heat storage, thermoregulated properties. They generate voltage when exposed to pressure, changes in pH, vibration, a magnetic field, or temperature. Finally, very (ultra) smart materials work like the brain, with cognition, reasoning and activating capabilities. It includes shape-memory alloys, smart polymers, smart fluids and others that can reshape themselves and adapt to environmental conditions (Syduzzaman, Patwary, Farhana, & Ahmed, 2015; Pailes-Friedman, 2016).

Pailes-Friedman (2016) explores smart textiles in six categories according to their usage, performance, and material types (Table 8). The first category is performance enhancement textiles, including fabrics designed to increase speed, mobility, and endurance to promote body performance and physical activities. They are mainly found in sportswear apparel. Next is the safety and protection category, mainly fabrics that optimize user safety and productivity with features like abrasion or slip resistance, heat or chemical protection and improve performance. They are also used on sports apparel and military, special-occasion apparel for astronauts, firefighters, or security departments. The other category is nanotechnology, which manipulates materials at an atomic or molecular level with chemical fabric finishes or coatings. The E-textiles category is mainly about conductive materials that enable digital components, electrical circuits, batteries, and other embedded electronics. They are able to generate or store power, communicate, transform (e.g. light, colour) and conduct energy. The other is non-woven textiles which are foams, films, and laminated composite materials with advanced developments. They are being used for body protection for contact sports and beyond. Finally, smart foams, which work to free the user from heavy, bulky, and awkward padding, provide a full range of motion and encourage the use of protective equipment. This category also highlights experimental research with computational graphics, 3D rendering, biological materials for sustainable focus and spray-on clothing.

Table 8. Survey baseline of smart textiles (Pailes-Friedman, 2016, pp. 39-71)

Categories	**Performance and Smart Material Types**
Performance Enhancement	**Increased mobility** (elastomeric fibres with high elasticity, fully recover original shape) **Thermoregulators** (control energy and constant temperature, regulate body heat) **Coldblack** (regulate the surface temperature of the skin, protect both UVA and UVB rays) **Aerodynamics** (reduce drag and create better airflow, reduce skin vibration, muscle oscillation, rubberizing, waterproofing) **AeroSwift technology** (glue and flat seaming techniques, elastic, breathable, abrasion-resistant, aerodynamics) **Moisture management** (control movement of water vapour and liquid water in the form of perspiration; waterproof, windproof, breathable fabrics)
Safety and Protection	**Shielding** (protect from radio waves, electromagnetic fields) **Extreme environment protection** (form barriers against harsh chemicals, radiation, and heat) **Flame and high-heat protection** (fire protection, abrasion-proof)

	Abrasion, cut, and penetration resistance (protect against heat, cuts, abrasion, penetration) **Reflectivity** (provides extensive protection in poor visibility, coated/bonded, elastic/non-elastic)
Nanotechnology	**Odour control and antimicrobials** (reduce bacterial growth, inhibit the reproduction of bacteria, mites, and fungi) **Soil and stain release** (resists a wide array of water and oil-based substances; push of dirt, soil, water by nano-coating) **Shape memory: artificial muscles** (crumple and relax in reaction to stimuli like heat or sweat; light, flexible, heat/electricity conductor) **Super hydrophobics** (completely repel water and heavy oils, prevent corrosion, icing) **Cosmeto-textiles** (provide moisture, aromatherapy, scent, and anti-ageing)
E-textiles (electronic textiles)	**Conductivity** (conduct electricity, store data, generate and store power with metal fibres twisted into yarns, light, flexible, ductile) **Energy harvesting, storage, and generation** (fabric based lithium-ion batteries, solar energy harvesting textile) **Illumination** (photoluminescent inks, embedded LEDs, fibre optics transform with light and colour, increase luminosity in response to their surroundings -a glow-in-the-dark effect) **Colour changing** (light and colour changing inks with temperature)
Non-woven materials	**Insulation** (thermal and cooling quality) **Impact protection** (reduce the feel and profile of any padding allow a greater range of motion and mobility)
Smart foams	**Experimental research** (3D printing, biological materials, spray-on clothing)

This survey above lists recent, improved and experimented textiles and related materials. All materials are being applied successfully in various fashionable wearable projects, and some of them are still in progress for enhancement (Pailes-Friedman, 2016). Significantly, the experimental research area combines the features of other categories in the conceptual exploration to form a baseline to invent the future of fabrics. Other forecast reports also highlight the high-tech enhancements and growing class of devices in wearable technology and textile technology fields (Milshina, Pavlova, & Vishnevskiy, 2019; PSFK Labs, 2014). Milshina, et al.'s (2019) forecasts the future of the textile and apparel industry through timelines and wild cards. They stress that the textile and apparel industry has great potential for technological innovation and brings a "high degree of uncertainty". Figure 22 indicates high, medium and low possibilities of textile and other advanced technology innovations regarding the global trends from the present time to 2030.

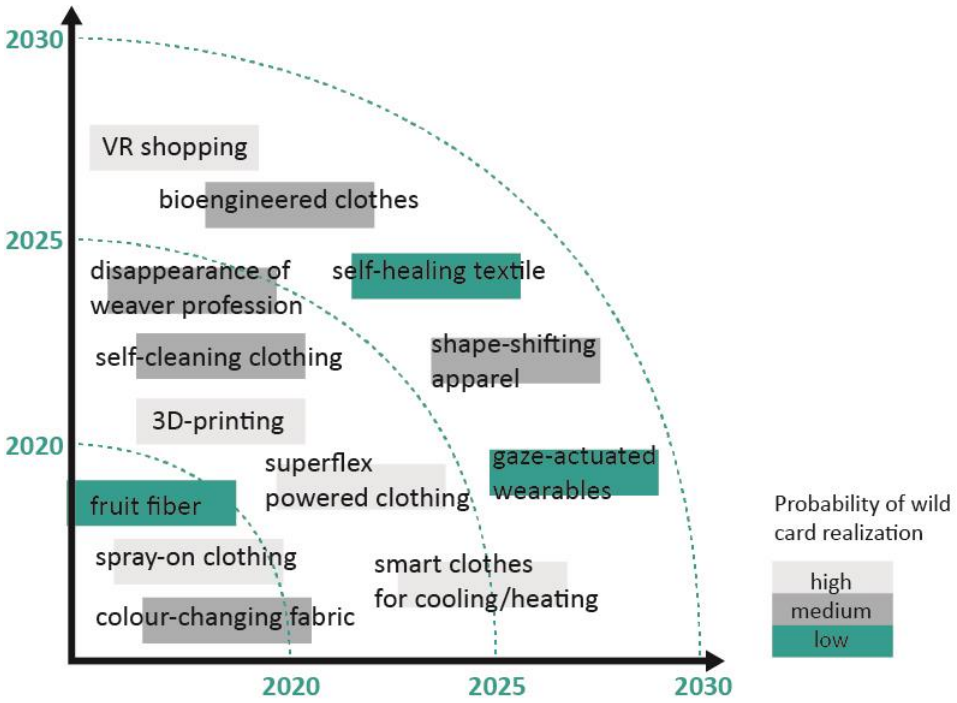


Figure 22. Radar of wild cards for the future of the global textile and apparel industry (adapted from Milshina, Pavlova, & Vishnevskiy, 2019)

To sum up, digital and textile technologies introduce significant opportunities for fashionable wearables. Elise Co, who designed many garments utilizing luminosity, remote activation and bodily sensors starting from 1998, emphasizes how technology "expand the vocabulary of fashion and change the way we think about our bodies as they relate to others and the environment" (Ryan, 2008; Co, 1998). When we see the global trends and forecasting reports mentioned in the "fashionable technology" section, it is expected to experience the gaining momentum of fashionable wearables. Of course, several challenges that must be faced and need to be properly addressed, such as large-scale production, washability of the fabric, user acceptance in terms of psychological parameters or affordability (Kinkeldei, Münzenrieder, & Tröster, 2013), privacy and security-related challenges of IoT systems (Thierer, 2015). Information and communication technologies have a radical impact on people and affect self-conception, mutual interactions, the conception of reality, and interactions with reality (Floridi, 2015). Taking a holistic approach across all ethical dilemmas to better uncover and address inevitable problems has been suggested as one of the roadmaps (Silverglate, Kosmowski, Horn, & Jarvis, 2021). Fashion and clothing also face a significant constraint that is related to the human figure and the body as a dynamic interface; however, it also gives vitality, optimism and inventiveness (Ryan, 2008; Manovich, 2001). Ongoing experimental

research, fashionable wearable projects, and forecasting reports all point out the market's huge potential, and these challenges can be overcome in the future.

CHAPTER 2

METHODOLOGY

This chapter outlines the overarching strategy and approach for conducting this research which was structured to meet the established objectives. First, we introduce the overall research approach and after, we present the research methodology together with a discussion of its relevance to the aim of the research. Finally, research methods are introduced.

2.1 Research Approach

There are various ways of approaching a problem. In this section, we present the research approach adopted to conduct this study.

Research and design are closely related in a way of being intentional activities of creating something new. Acher's (1981) definition for the research is "a systematic enquiry, the goal of which is knowledge". This emphasises that in order to find answers to questions, "research" must be pursued according to some fixed plan. According to Downtown's (2003, p. 1) definition for design which "is a way of requiring, a way of producing knowing and knowledge; this means it is a way of researching", some similarities between design and research appear. However, they differ in the way they are conducted (Stappers & Giaccardi, n. d.). Muratovski (2016) argues that practice of design is rarely a research-driven process aimed at producing new knowledge and design process is not necessarily need to be systematic. Shortly, there are both similarities and differences.

These similarities and differences of design and research notions creates several concepts. According to Frayling's (1993) approach, design research distinguishes between research into design, research for design and research through design. "Research into design" is doing research into variety of perspectives and theories of design field. "Research for design" is doing research as a part of doing design. In this concept, the end product is an artefact and scientific information is gathered to meet the artefact.

Our study can be inscribed on what Frayling (1993) called "research through design", which is basically "doing design as a part of doing research" (Stappers & Giaccardi, n. d.). Pontis

(2010) indicates that research through design "involves both understanding the design process itself and developing new design actions, artefacts or methods". Therefore, design activities play a formative role in the generation of knowledge. This "designerly" contribution might be as simple as making stimulus material for use in research. However, more typically, it consists of developing a prototype (or artifact) that could be mistaken for a 'product', which plays a central role in the knowledge-generating process (Stappers & Giaccardi, n. d.). Another perspective from Keyson and Bruns (Keyson & Bruns, 2009, p. 4548) is remarked as:

> *Research through design focuses on the role of the product prototype as an instrument of design knowledge enquiry. The prototype can evolve in degrees of granularity, from interactive mockups to fully functional prototypes, as a means to formulate, develop and validate design knowledge.*

In the case of our study, we iteratively constructed a prototype adopting various design and research methods to explore our main research question better. Plus, we explored secondary objectives and evaluated the impact of a conceptual design intended to help change how users address problems relating to target behaviours.

As a backbone of our research, we adopted Human-Centred Design (HCD) approach to gain information about user's needs, demands, perceptions and to assess "motivation" levels and "ability" (simplicity and usability of the product) regarding the behaviour change model (Fogg, 2009). HCD aims to make interactive systems more usable by focusing on the use of the system and applying human factors/ergonomics and usability knowledge and techniques (ISO, 2019).

In this study, we use the term HCD rather than User-Centred Design (UCD) to emphasize the impacts of our proposal on a broader number of stakeholders, not just a specific target user. Plus, this study is not primarily focused on the tangible, physiological ways users interact with a system, but more on incorporating people's emotional or psychological preferences. However, on later phases of the research, we produced a semi-functional prototype, which was the outcome of the conceptual design phase, so far that phase we adopt on approach closer to UCD. In these later phases, when design decisions are more specific/concrete, focusing on details of the interface and interaction. UCD methods provide the opportunity to refine the fashionable wearable. Thus, user and product interaction, the good experience, positive feedback from users will provide a micro-level of sustainable behaviour adoption.

Daae and Boks' (2017) DfBC Tool, was used to design the concept, decide the level of user control, and achieve the behaviour change effectively.

Generically, our methodology follows a combination of the design and research process synthesized from User Experience (UX) Process Lifecycle (Hartson & Pyla, 2012), The Hasso Plattner Institute of Design at Stanford (d.school) design thinking process (Interaction Design Foundation, n.d), and Design for Behaviour Change Process (Wendel, 2014) (Figure 23).

<table>
<tr><td>UX Process Lifecycle</td><td colspan="2">Analyse:
Understand user work and needs</td><td>Design:
Create interaction design concepts</td><td>Prototype:
Realize design alternatives</td><td>Evaluate:
Verify and refine interaction design</td></tr>
<tr><td>d.school design thinking</td><td>Empathize:
Research your user's needs</td><td>Define:
State your user's needs and problems</td><td>Ideate:
Challenge assumptions and create ideas</td><td>Prototype:
Start to Create solutions</td><td>Test:
Try Your Solutions Out</td></tr>
<tr><td>Design for Behaviour Change Process</td><td>Understand:
how the mind decides to act and what that means for behaviour change</td><td>Discover:
the right behaviours to change, given your goals and your users' goals</td><td colspan="2">Design:
the product itself around that behaviour. (Conceptual design - Interface design)</td><td>Refine:
the product's impact based on careful measurement and analysis</td></tr>
</table>

Figure 23. Methodology mapping of UX Lifecycle, d.school design thinking and DfBC Process

2.2 Research Strategy

There are different classifications for defining types of research design. According to Kumar's (2011) classification, if you examine a research study from the perspective of its objectives, four types of research can be found: descriptive, correlational, explanatory and exploratory (Table 9).

Table 9. Types of research: objectives perspective by Kumar (2011)

Descriptive study	Attempts to describe a situation systematically, problem, phenomenon, service or program, or provides information, describes attitudes towards an issue
Correlational study	Aims to discover or establish the existence of a relationship between two or more aspects of a situation
Explanatory study	Attempts to clarify why and how there is a relationship between two aspects of a situation or phenomenon
Exploratory study	To explore an area where little is known or to investigate possibilities of undertaking a particular research study

As mentioned in the previous chapters, the context of the study is at the intersection of different fields, including sustainable behaviour, smart mobility and fashionable wearables. Available sources are limited and disconnected from each other, as the literature review supports. The aim of using smart products in the field of fashion as a significant motivation for a behaviour change, seeks new insights and investigates possibilities. Thus, the research will be exploratory in nature from an objective's perspective.

Another classification of research can be found from the mode of enquiry perspective. Generally, it is divided into two as quantitative and qualitative research. The main focus in qualitative research is to understand, explain, explore, discover and clarify situations, feelings, perceptions, attitudes, values, beliefs and experiences of a group of people (Kumar R. , 2011, p. 104). According to the scope of the study, information gathering methods and processes are often flexible and less structured than quantitative design. In qualitative research, the measurement and classification requirements of the information gathered to demand that study designs are more structured, rigid, fixed and predetermined in their use to ensure accuracy in measurement and clarification (Kumar R. , 2011, p. 104).

In addition to these major study methods, "mixed methods research" is also raised as an alternative strategy of inquiry (Cresswell, 2009). "Mixed methods research", also known as "multimethod research" or "mixed methodology" (Muratovski, 2016), involves collecting, analysing, and in some way integrating both qualitative and quantitative data in a single project (Leavy, 2017). It is mainly used in applied social and behavioural science research, seeks to trigger community change or social action. The phases are rather integrated or synergistic, with the qualitative phase influencing the qualitative phase or vice versa (Leavy, 2017; Hesse-Biber, 2010). Therefore, this PhD research can be described as mixed methods research as the study's main purpose is to explore how and to what extent solutions of fashionable wearables can promote more sustainable behaviours in smart cities. We need to understand the users, explain the experiences and perceptions, and finally evaluate the motivation level of users. Thus, we need to use both qualitative and quantitative data collection methods to explore, identify, generate and verify certain issues to meet objectives.

This mixed-methods exploratory nature of the study is structured as five iterative phases. Figure 24 demonstrates a linear sequence of phases with the strategies; however, the process

is nonlinear, and many repetitions and loops for concept explorations, refinement of analysis within and between phases are performed.

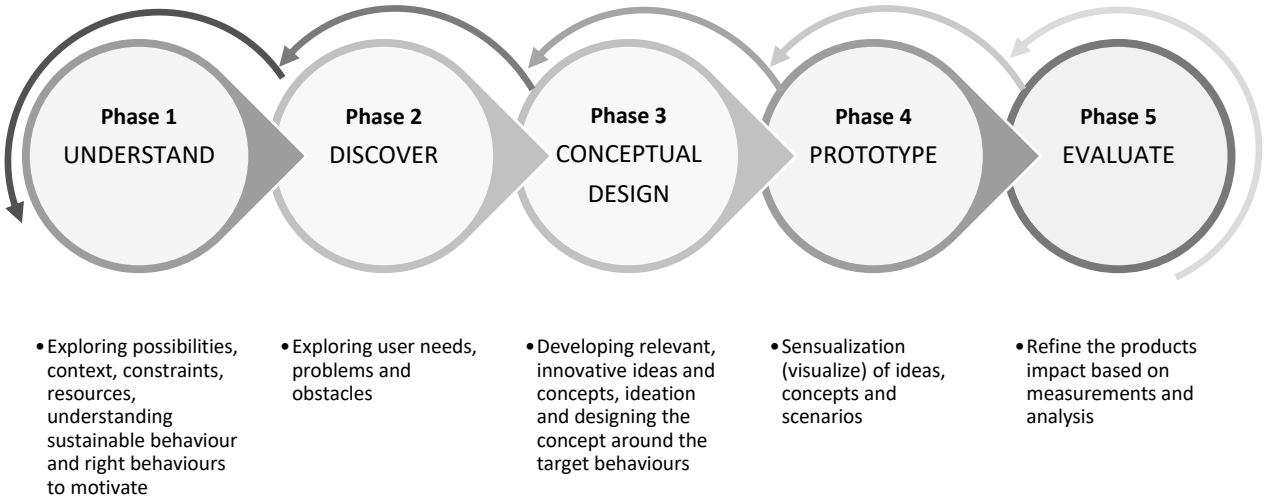


Figure 24. Five Research Phases

2.3 Research Methods

This section introduces the research methods used in this study. Research methods aim to address how validated techniques and tools can be brought together to accomplish the strategies and objectives of each phase. Phases' tasks were accomplished using the research methods and tools shown in Figure 25.

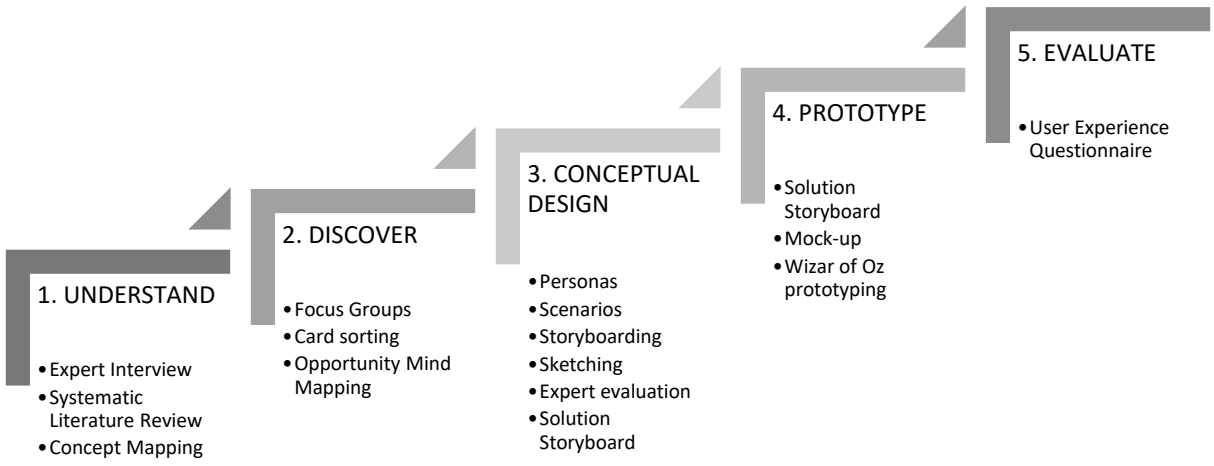


Figure 25. Research methods and tools that were used in corresponding phases

In the next chapter, we will be presenting research development, results and discussions. While explaining the development of each research phase, we will also indicate the

methodology of phases. Description of research methods and techniques that were used to gather and analyse data for the corresponding phase will be shortly explained in the following chapter’s sections.

CHAPTER 3

RESEARCH DEVELOPMENT, RESULTS AND DISCUSSION

This chapter presents the development of the research and is organised into five sub-chapters, the same that make up the stages of the methodology adopted, as explained in the previous chapter. For each part, we present an introduction, the methods used, the results obtained and their discussion, highlighting the main findings that feed the next phase.

3.1 Phase One: Understand

To update and deepen the knowledge about the fields under investigation, we conducted a literature review (see Chapter 2) as well as expert interviews and we end this phase with a map of sustainable behaviours.

3.1.1 Methods

The following methods were used in Phase One:

Expert Interview: Interviews are one of the most frequently used user research techniques, a guided conversation in which one person seeks information from others (Baxter, Courage, & Caine, 2015). Specifically, experts are able to enlighten researchers quickly on a topic and give critical insights into relevant context and innovations (IDEO, 2015). The expert interview has been a widely discussed qualitative method in political and social research since the early 1990s and collect data about specific fields of interest (Döringer, 2021). By talking to experts with experience in the sustainability field, we aimed to get insights and experiences to understand essentials of sustainability and sustainable behaviours. We preferred semi-structured interviews with pre-determined questions that serve as a checklist of topics to be covered, and wording or order of questions that might be modified on the flow of the interview (Robson & McCartan, 2016).

Systematic Literature Review: A literature review is an overview of the previously published works on a specific topic. By being systematic in carrying out such a review and fully explicit in describing the process followed, it is possible to carry out a very worthwhile review

(Robson & McCartan, 2016). A systematic literature review identifies, selects primary studies, extracts, analyses, and synthesizes data in order to answer a clearly formulated research question (Xiao & Watson, 2019). The systematic review is viewed as being very similar to surveys. "The difference being that while surveys are of people, systematic reviews are surveys of the literature" (Robson & McCartan, 2016, p. 85). We are seeking sustainable behaviours in the literature and asserted examples on the topic by using related keywords. The findings from the literature review are reported in the form of concept mapping.

Concept Mapping: Mapping is commonly presented as one of the practical tools for conducting a literature review (Hart, 1998; Alias & Suradi, 2008). Concept maps are graphical representations of different concepts, emphasizing the relationships between topics (Gibbons, 2019), ideas, practice, and if necessary, highlight relevant examples (Hart, 1998). Demonstrating relationships in a visual form helps the researcher to find interconnections between concepts. In our study, based on findings from the literature review, we linked concepts related to types of sustainable behaviours, practice and design for sustainable behaviours, in everyday life domains causing negative impacts on the selected framework. This mapping enabled us to find sustainable behaviour examples from the literature and identify the sustainable behaviour concept.

3.1.2 Expert Interviews

The expert interview step was practised in 4 phases:

Knowledge expansion: As a way of expanding and deepening knowledge we conducted a literature review, which helped us to understand the essence of sustainability and sustainable behaviour in the field of design and psychology. The main outcomes of this phase were presented in Chapter 2.

Materials and preparation of content: The first steps in this process consisted of identifying experts through their biographies, publication topics, courses they lecture, projects they conducted and obtaining their contacts, as well as preparing a script to support the interviews.

Expert interviews were prepared in English, considering a face-to-face format based on a semi-structured questionnaire. Fourteen base open-ended questions were prepared (Table 10), but questions could be omitted or added, as well as their sequence changed depending on the

flow of the conversation. Likewise, there may have been some occasional rephrasing or the need to provide additional clarification when the understanding of the questions was at risk.

The base open questions were basically focused on the perception of sustainability, sustainable behaviours, the understanding of users and their behaviours, what kind of behaviours can be considered as sustainable and how to overcome the obstacles of adopting sustainable behaviours.

Table 10. Base structure of the expert interview

Introduction	Introduction of research Quick feedback for the interview Consent form exchange
Warm-up	**1.** Could you tell me briefly about yourself in terms of your professional career, projects that you participated in/coordinated on the topic of sustainability?
Detailed questions	*The Brundtland Report (WCED, 1987) explains the term simply as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". This holistic and flexible definition is still lasting since it is open to interpretation.* *Elkington (1994), creator of the term Triple Bottom Line, "sustainability is the balance between the three pillars: environmental, economic and social."* *Sustainability is "the ability of a human, natural or mixed system to resist or adapt to endogenous or exogenous change indefinitely (DOVERS; HANDMER, 1992), represented as a goal or endpoint (HOVE, 2009).* *According to Ayres (2008), sustainability is a normative concept about how humans should act in relation to nature, and how they are responsible for each other and future generations.* **2.** There are many examples of diverse definitions for sustainability. Could you define "sustainability" in your own words? [what] What does "sustainability" mean to you? [why/importance] *General Assembly announced 17 goals and 169 targets to stimulate action in the concept of sustainability including the topic such as zero hunger, wellbeing, education quality, gender equality, sustainable cities, climate action and so forth. More recently, approaches are focusing on cleaner productions, pollution control, environmental/waste management, social responsibility, eco-design, reuse, zero waste, among many other terms, disregarding other responsibilities.* **3.** Based on your experience, do you think we (users, researchers, companies, etc.) disregard our responsibilities and/or concerns about sustainability? (Disregarding some of the responsibilities of sustainability?) All the pillars of the concept are being concerned equally or together? **4.** In your opinion, what are the main difficulties/obstacles to sustainability? **5.** How can a behaviour be considered "sustainable" (if it can be considered)? What does "sustainable behaviour" mean? Could you give me some examples of what could be "sustainable behaviours"? <answer> In the restricted context of city life, as a citizen, could you give me

	examples of what could be sustainable behaviours? **6.** Do you know any studies related to behaviour change for sustainability, focusing on sustainable behaviour? Can you indicate some? <answer> In your opinion, to what extent can design change behaviours and, this way, contribute to sustainability? **7.** What might be the major unsustainable impacts of people's everyday life? <answer> Do you think city life, by opposition to living in other locations (country, mountain,...), has additional impacts on our everyday life? If yes, tell me some (e.g., exposure to noise, pollution, traffic congestions, etc..) **8.** In your opinion, what are the main reasons people adopt an unsustainable way of behaving? <answer> What might be their reasonable, internal or external, excuses/reasons to behave like that? [obstacles] **9.** Considering these obstacles for sustainable behaviour, to what extent do you think fashion (both as a "symbol" or notion, in any kind of product in the context of "apparel" products) can overcome these obstacles? **10.** To what extent do you think technology (smart product/systems, IoT...) can overcome these obstacles? **11.** To what extent do you think fashionable wearables (might be a garment, accessory,...) can overcome these obstacles? **12.** What kind of sustainable behaviours can be promoted with fashionable wearables? <answer> In the context of the smart city?
Cooling-off /Summary	**13.** Considering everything we talked about today, do you have any suggestions, advice or traps I should avoid coming to your mind related to this research?
Wrap-up	**14.** Is there anything you would like to highlight or emphasize as a conclusion?

Data collection: Interviews were conducted with nine experts with different backgrounds, chosen randomly from those with projects in the field of design for sustainability and in Portugal. Ten experts were contacted via email or face-to-face conversations, and we managed to arrange meetings with five of them. Table 11 describes the expert profiles, but their personal details are omitted to ensure anonymity.

Table 11. Expert profiles

Expert	Year of Birth	Background	Sustainability expertise	Professional activity
E1	1977	Industrial design	Circular economy,	Industrial designer,

			circular design	Researcher
E2	1978	Industrial design, Urban design	Sustainable design, co-design	Researcher, Lecturer
E3	1981	Graphic design, Marketing	Sustainable design education	Freelance designer, Lecturer
E4	1967	Fashion design, Communication design	Sustainable communication design	Freelance designer, Lecturer
E5	1977	Industrial design, Furniture design	Sustainable design, eco-design	Freelance designer, Lecturer

Data analysis: All expert interviews took place in Lisbon individually. The interviews were scheduled to last approximately one hour. The contents were digitally audio recorded and later fully transcribed (Appendix A).

The relevant statements of each expert were coded according to the objectives of the study, giving rise to tables (See appendix A to H). MAX Qualitative Data Analysis (MAXqda) was used to perform a qualitative analysis of each interview, highlighting, and tagging important statements and keywords related to each consideration.

3.1.2.1 Analysis and Discussion

3.1.2.1.1 Understanding Sustainability and Identifying Obstacles

Although we discussed the meaning of sustainability in Literature Review, we wanted to understand how experts understood and defined sustainability to discover similarities and differences between their views and the definitions available in the literature.

To define sustainability, the experts used terms such as “the link”, “the balance”, “the measure”, “a way of conveying message” and “the ability”, which were intangible and with a connective meaning. Therefore, we thought that, to make sense, the concept requires the integration of different pillars such as environment and society. The term was also defined from the perspective of human behaviour as, for example, “the impact they cause”, “to be aware of” or “to choose better”.

The following sentences illustrate these observations:

> *“Sustainability for me, to use correctly the link between 3 pillars: Environment, social and economic part. Without one of the pillars, you can’t achieve sustainability.” (E1)*

"You have to find the balance between what you need and what you take. I think the best word to define sustainability is balance." (E2)

"I think you should understand sustainability as the measure of least impact." (E2)

"Trying to find the best. I think it is really simple. (…) just looking at the nature and see how the universe works, how nature works. It is basically that." (E2)

"Sustainability was a pulse to mean that it sustains itself throughout time. Something that can be resilient and sustain itself throughout time." (E3)

"My definition of sustainability is a way of conveying a message in the way that we look for a better sustainable result. The question is how can I contribute, providing a better (sustainable) service, informing the client and allowing the client to do better work." (E4)

"Without trying to be very dark, sustainability is the ability as society tries to encompass all the areas of human development and try to harmonize that with an ecosystem so the function of the planet." (E5)

The experts highlighted that sustainability concept is frequently misunderstood in society. They also stressed that there are many false assumptions about it that must be corrected, and sustainability is hard to achieve. To point out the difficulty of understanding and achieving the concept, some experts used statements such as "you never achieve", "it is a utopia", "it is really hard for us".

The following sentences illustrate these observations:

"I think you should understand sustainability as the measure of least impact. Because normally, when you think sustainability is something that doesn't have an impact which is false. Everything has an impact. When you have that mind shift between, not having an impact or "This is a green product", this is a lie, of course, it is not." (E2)

"I don't think that overall, we understand what sustainability means. Sustainability was a pulse to mean that it sustains itself throughout time. Something that can be resilient and sustain itself throughout time. We as human beings, we don't have a good appreciation of time in a long term. We have a short memory, and we don't really care about what is going to happen in the future. So, it is really hard for us to internalize the concept that we don't need all that we have." (E3)

"It is so much and so big that it is very hard to be 100% sustainable. I think it is a utopia." (E4)

"Sustainability is something always shifting, changing, so we have to continuously improve and change our process. Sustainable development is not something that we can implement, and 'Ok, we are doing a sustainable development; therefore, we are sustainable'. It is something that you want to achieve, but you never achieve." (E5)

The difficulty of understanding the concept was pointed out when we asked for its definition. In addition, we also asked the experts about "What might be the obstacles to sustainability?". They reiterated the difficulty and the complexity of the approach, which can explain why people find difficult to understand the concept and act accordingly. The frequency with which

statements of this type were repeated, suggest that this issue may be one of the primary obstacles to sustainability.

The following sentences illustrate these observations:

> *"You have to have a holistic approach. Not just process that you have to work on the product, and lifecycle." (E1)*
>
> *"It is an old-fashioned word and is being used everywhere, and the meaning is not what we want. Because people are using the word for everything, so we are losing the meaning. Now, we need to be clever and be clearer about the definition, and we need to demonstrate the benefits." (E1)*
>
> *"So that's why the problem of real sustainability is its complexity; it has a lot of facts. When I was talking about the social part of it, it is exactly about that because it is normally easier just talking about resources. It is a physical thing; it is very objective, but when you talk about people, it is more subjective, so it is harder to pinpoint what it specifically means." (E2)*
>
> *"I think currently, not to generalize but the human race as a whole has some difficulty in understanding sustainability." (E2)*
>
> *"Even though it is a great concept, it is really hard for people to internalize." (E3)*
>
> *"It is so systemic and so complex that it is impossible to approach all sides. It is impossible to be 100% sustainable." (E4)*
>
> *"I think the main one is the complexity." (E5)*
>
> *"It is very difficult to approach. There is no one answer to it, so there is no one solution. To try to implement sustainable development or sustainability, we need several approaches, so everyone should work together towards that." (E5)*

The lack of understanding of the benefits and the importance of the concept seems to be another obstacle to its full implementation, making people not feel an obligation to behave in a sustainable way. Furthermore, in their opinion, the benefits of the sustainability are not only unknown to the average citizen, they are also unknown by businesses, designers and educators.

The following sentences illustrate these observations:

> *"Everyone talks about sustainability nowadays. (...) A lot of people don't believe in sustainability." (E1)*
>
> *"For me, most of the professionals that are working in the sustainability field are not able to demonstrate the benefits of the application in the context. From my experience, I have been working in a lot of projects, in all our projects, the idea is to evolve companies. It is really difficult to engage companies because they don't see the benefits." (E1)*
>
> *"Well, first is to realize the importance of it. It is a matter of accepting a sustainability is a way of doing something." (E2)*

"From my point of view, we as designers maybe not as researchers, we are neglecting sustainability a lot. (…) almost every single design school doesn't have sustainability as a pillar or core of a course." (E3)

"If you are discussing sustainability apart from the project, you might not embed that idea into the designer's mind. They might not understand how the product they do, impact either the environment or the society or the economy of their country. So, for us to be more aware, I think we need to shift education." (E3)

"There are many principles, steps that in some cases, the objectives are not quantifiable, in a sense that they don't have something… Well, if you don't implement them, you don't suffer anything." (E5)

For the experts, "Changing the mindset" and "habits", related to human behaviour, are an obstacle to sustainability by experts. For some, the Human culture and history can explain this phenomenon. Furthermore, the experts agreed that the social pillar of sustainability has also being disregarded by many of us.

The following sentences illustrate these observations:

"So, I would say that from the beginning the behaviour itself is an obstacle." (E2)

"You have to understand that you have to consume less, you have to change literally everyday habits. So, we are talking about literally every person on the planet. (…) It starts with behaviour and the first obstacle is to change the mindset." (E2)

"History. I guess. We have been doing things in a certain way. People used to do that and it works. We like it. We are spoiled by history." (E3)

"Our habits, by our culture. And changing that means that you have to give up a lot. I understand that but I don't know if I am ready to give up everything that I have. Are you? Are you ready to give up your clothes and your phone? I don't know… It is not easy. It is very hard. Because you have been thought that it is a good thing to have a car, a big apartment, luxurious, to have a big TV, all the services, streaming, the latest phone…" (E3)

"For instance, as a researcher, I think it is very nice to work with people and involve them to think on the social aspects. However, as a practitioner, I found it very hard to work with a supplier on the contrary. (…) It will increase so much on your price. Even your most committed sustainable clients won't go in sustainable way." (E4)

"I think all of us disregarding that (social pillar of sustainability). Not only we as citizens, our behaviours but also producers, designers. So, everyone, all the stakeholders at some point are disregarding, missing something." (E5)

The lack of understanding of sustainable solutions and emergence of "consumption" or "over consumption" were also identified as a major obstacle by the experts. Although this issue could be analysed in the previous sections, the frequency with which it was mentioned by all the experts made us choose to analyse this issue separately. Sustainable solutions were mostly found at the end-of-life of the products. In this sense, people continue to consume and assume

that solutions such as “recycling the products” would be sufficient. Unfortunately, this was not suggested as the logical approach.

The following sentences illustrate the results obtained:

> *“In the 70s, companies started to understand the problems for environment. They came up with end-of-life solutions. But what they were doing was to solve the problem in the end of production. They had waste; they made some facilities to take care of the waste. They had emissions, they put some filters and so on. It was the end of the pipe, and that solution was not good.” (E1)*

> *“Let’s talk about producing less impact. It is something that is not added-on and something that it is crucial for survival as species I would say. I don’t want to get extreme but it is.” (E2)*

> *“You really have to change the way of consumption. Even it is the first principle of sustainability. Just consume less. It is not recycling, reusing, reducing. The first one is to reduce. Recycling is the last one. And currently is the other way around.” (E2)*

3.1.2.1.2 Understanding Sustainable Behaviour

When reflecting on the meaning and obstacles to sustainability in the previous topic, the experts highlighted “human behaviour”, “habits”, and “sustainable behaviour” as core concepts. This “human” aspect was explored at different levels, such as the lack of understanding of the concept, the lack of understanding the benefits, and the difficulty of changing the mindset. Moreover, the importance of promoting sustainable habits and changing human behaviour as one of the main keys to achieving success is also supported by the literature.

To grasp the current understanding of sustainable behaviours is one of the important steps for this research. We mentioned the design strategies, theories, models and frameworks to influence sustainable behaviour and lifestyles in Literature Review Chapter.

Most of the approaches reviewed focused on “how” to persuade users to behave in a desired way. However, to inform better our subsequent design decisions, we wanted to understand “what kind” of behaviours can be considered as sustainable and which behaviours in the city life might have more negative impact.

As a start, we asked the experts to define sustainable behaviour. We got two definitions:

> *“Sustainable behaviour is to look at the products and have a notion of their lifecycle.” (E1)*

"For me a sustainable behaviour is the behaviour which people are aware that their personal choices have a certain impact. They are able to measure somehow that impact is minimized or at least have a way to return that impact by just choosing things that are better designed, last longer, choose to consume less, consume what you need." (E2)

Other experts have tried to define sustainable behaviour using some examples or they pointed out mistakes made by people. This may be an indication of the complexity of the concept.

The following sentences illustrate the results obtained:

"I don't know. The reason why I don't know is that everything is very complex like I have just said. Every decision that you are making whole bunch of little decisions, you may go to Celeiro (Portuguese health food store) to buy an organic food. But for instance, let's say that the lighting that they are using there doesn't come from renewable sources. Ok, I am buying organic but there is a whole bunch of other things, how about the people work in there? Are they being treated, being paid enough? Because sustainability is also about people." (E3)

"Sustainable behaviour means that you have to do such an effort. It shouldn't be like this. Solutions should come step by step to you and help you to improve your daily behaviour." (E4)

"It is related to the impact of that behaviour. If you have a behaviour that cause a negative environmental and social impact, it is not a sustainable behaviour." (E5)

Interestingly, one of the experts noted that, in his/her opinion, the concept of "sustainable behaviour" was not the right one. Instead, we should use the concept "more sustainable behaviour".

"I don't believe in fully sustainable behaviour and also fully sustainable product. It is roughly the same thing as we were talking about sustainability. Something we cannot achieve, here is the same. There is always some sort of impact when you develop an action or product. You can reduce that impact but it will always be there something. So, the correct phrase or expression should be "more sustainable behaviour", in my opinion." (E5)

Examples of what might be considered sustainable behaviours, gathered from experts' replies to the questions - "How can a behaviour be considered as sustainable?" and "Can you give some examples to sustainable behaviour", can be found in the Table 12. Other related examples were clustered into 18 topics and their frequency assessed. Results reveal that "consuming less resources" was the sustainable behaviour more often mentioned by the experts.

The following statements are representative:

"Understand that we don't need everything that we have" (E3),

"When you want to buy something, you choose based on information. This case, if you just do this exercise "Do I really need this?", it will be really simple. You just stop and think a

bit, breathe, "Do I really need this?", "Do I need a second thing?" or "Do I really need to go there or spend this or that?" (E2)

"Reduce the need of buying something, thinking if we can do it another way." (E5)

Another strong idea that came up was "to be aware and having a conscious". Four experts suggest that if we know the impacts of our behaviours and the impacts of the products we choose to buy, we are already engaged with a sustainable behaviour. "Choosing or trying to be informed" about what you are buying and, in the context of mobility, "Using bike" or "Bike-sharing" in the cities and "using public transportation" were examples given by at least three experts separately. When we reconsidered these mostly asserted 5 examples for sustainable behaviour in everyday life, these behaviours were related to understanding the concept itself, reducing the need of buying, and sustainable mobility choices.

Other examples of behaviours, such as "walking", "not wasting energy", "recycling", "choosing responsible brands" and "organic farming/buying organic food" were mentioned by two experts. The remaining examples, as demonstrated on Table 12, were mentioned by one expert.

Table 12. Sustainable behaviour examples given by experts

	Sustainable Behaviour Examples	**Experts**
1	Consume less / Avoid the urge of "I need everything" Reduce the need for buying	E1, E2, E3, E4, E5
2	To be aware / Having a conscious / Knowing the impact	E2, E3, E4, E5
3	Try to be informed	E2, E3, E4
4	Use bike / Bike-sharing	E3, E4, E5
5	Use public transportation	E3, E4, E5
6	Walk	E4, E5
7	Don't waste energy	E1, E4
8	Recycle	E1, E5
9	Choose responsible brands	E2, E4
10	Organic farming / Buy organic food	E2, E3
11	Don't waste water	E1
12	Use electric mobility	E1
13	Produce locally	E2
14	Lower carbon print on production	E2
15	Use sharing mobility	E3
16	Better use the sun (e.g., using solar panels)	E3
17	City farming	E3
18	Reduce the number of materials in a product while designing	E5

Some contradictory arguments were presented by the experts during the interviews. Although "recycling" was given by some experts as an example of sustainable behaviour, others pointed out that this type of behaviour should not be a primary approach, among others:

> *"3R policy: Reduce, reuse, recycle. Nowadays, we think that we need to recycle and recycle. But that is not the order of the situation. We need to reduce and if we cannot reduce, then step 2 is reuse. Only in the end if these two possibilities are not available, then we recycle." (E5)*

Electric mobility choices were also discussed by the experts. Some recommended electric bikes or electric cars; however, they were hesitant and gave examples of negative sides related to these vehicles.

> *"If you walk, ride a bicycle or use public transportation the impact is far better than the electrical one" (E5)*

> *"We are always talking about electrical vehicles. Although the product itself has more impact on the environment than the non-electrical one. Because of the batteries, mainly. We are thinking about electrical vehicles and change the paradigm but maybe it is not the best solution." (E5)*

3.1.2.1.3 Negative Impacts of Everyday Life

To deepen our understanding of what sustainable behaviours might be, we found necessary to consider the context of everyday life. In this sense, we asked two questions - "What might be the major unsustainable impacts of people's everyday life?", with the intention of helping us circumscribe the problem on which we should focus and - "Do you think city life, by opposition to living in other locations (country, mountain, ...) has additional impacts in our everyday life?", intended to help experts to think specifically about city life and, by comparison with other contexts, find additional behaviours (more or less sustainable) that are distinctive of the city context.

The table 13 contains the answers to the first question. Most experts considered "consumption" or "overconsumption" as causes of the greatest negative impacts in everyday life. Some experts gave examples to the things that people consume, of which "energy" and "food" stood out, which should be prioritised to achieve sustainability. Although most experts answered the question without any hesitation, one expert had difficulty coming up with an important example but, instead, mentioned that there would be many. Similarly,

"overconsumption" was also dealt with in a vague and generic way, encompassing a variety of topics.

Table 13. Major unsustainable impacts of everyday life

Expert	Quotes
E1	Overconsumption. We buy more than we need. Nowadays they stay at home, on computer, telephones, tablets and so on. They consume a lot more energy. (…) Transport also. Food waste.
E2	Literally more impact in terms of consumption. For instance, food. Reducing food is something consumes a lot of resources
E3	Consumption. That is the endorphin that keeps you this pleasure in your mind "Oh, that is so good!". It is like buying. When you buy something, until you get home and you see that again that buying has not been completed. You buy that, you put it on bag, you take it home, you open again and all the feelings come again and ok now it is completed.
E4	It can be so many. Very few people know that 10% of the emission comes from fashion, and everybody thinks that it might be electricity or the gasoline of the car. Of course, they all contribute but, in the end, just one t-shirt or one pair of jeans have a huge impact.
E5	I think nowadays is the use of energy. Because everything we use the gadgets, transports, all others consume energy.

Answers to the second question can be found in the Table 4.5. Surprisingly, all experts suggested that urban living is much more efficient in what concerns sustainability than living in other locations. We expected that topics such as air and water pollution, as well as noise, among other variables that disturb the environment, would be identified as unsustainable outcomes of city life, however, the experts focused on the positive aspects of living in a city; e.g., Cities give access to people; everything is more compact and closer to each other, so less energy is being spent while distribution of services or any kinds of human need.

Instead, the problem about cities were associated with "scale" and "supply". As cities expand, more resources are needed to maintain them. Also, things that are not generated in the city need to arrive to the city, which creates a large carbon footprint.

Table 14. City life issues

Expert	Quotes
E1	I don't live in the city. My daily energy consumption is huge. Because I come to city everyday by car. I need car to go shopping. If I don't have potatoes at home, I need to use my car to get just potatoes. In city, you don't need that. We have everything closer and you spend less energy because of transport. In the city, houses are smaller than outside. And outside you have larger houses that

	consume more energy more materials also.
E2	You can say of course city has more impact in the environment, social sustainability of people, their well-being or health. I also think it does but it doesn't mean that the city is not a good structure or it is not a good way to go. The problem is, another issue for me in terms of sustainability is scale. The problem is scale. Everything that passes a certain level, starts to be unbalanced to maintain. As people and cities are scaling up, you need more resources to maintain it. So, scale is important. Of course, if you are alone in your large wooden or mountain, your impact is not even relevant in nature because your scale is very small. But at the level of city, it is different. If you want to sustain cities, which is a good thing, cities are very ingenious way to increase the quality of life for a large number of people.
E3	From the sustainable point of view, actually the cities are very good. Because usually when you have to distribute a service, to places to spread it is not a very sustainable approach. In cities, everything that you do, every little thing, you give access to a lot of people
E4	We need the nature, I think when we live in the cities all day all night, all our life. And then we experience going outside, living with trees, grass, birds, sea... I think it comes something inside of us makes a huge impact on us. (…) not being in touch with nature is a huge avoid.
E5	The urban living is much more efficient than living in the country. Because everything is much closer, together, we have public transport, water and electric networks, everything is more compact and efficient. If I live in a house in the middle of the country and I need to buy a pack of rice, I have to go 5km for buying the rice. If my house is in the city, I just need to cross the street. The only problem in cities is supply, the things that are not generated in the city, need to arrive to city, like suppliers of the food.

3.1.2.1.4 Understanding People and Obstacles to Sustainable Behaviour

After trying to better understand what could be considered a sustainable behaviour, by defining it and giving examples, we also wanted to know what could be, in the opinion of experts, the main reasons for people to adopt unsustainable behaviours, as well as what could be their reasonable excuses, internal or external, for behaving in that way. Basically, we sought to find obstacles to sustainable behaviour. At this respect, the results indicate seven aspects, as follows:

The first is related to price. Most experts claimed that unsustainable options are mostly cheaper and being sustainable is more expensive. Therefore, if people do not have enough budget and their only concern is to survive, there will be no possibility to buy more expensive but sustainable things. The experts also pointed out that sustainable products are perceived as more expensive, although this is not always true for all products or services.

The following sentences illustrate the results obtained:

"Usually, and that is not true, but usually, sustainable products are more expensive. And the consumer just believes that being more sustainable is more expensive." (E1)

"Price is great constrain in sustainability." (E2)

"When you don't have a lot of money and you have to eat, of course you just want to eat. You don't care where things come from which is totally acceptable." (E2)

"I think it is easier, cheaper." (E4)

The second most mentioned reason was that people are not interested in the topic or basically do not care about it, most likely because being unsustainable was considered to be easier. The "Individualism" keyword was also highlighted by one of the experts and summarized most of the approaches. During our lifetime we have learned to behave in an unsustainable way and found it comfortable and easy. We want to live life the way we want and most of the time we do not take responsibility and we do not see any direct impact on us. Therefore, we don't care.

The following sentences are illustrative:

"I think that our society is not sustainable at all. Our nature is not to be sustainable. The change is in being sustainable." (E1)

"You are just doing your homework before you consume. Again, this is the tricky part because most of the people will say that they really don't have time to do that or would say they have time." (E2)

"People are a bit selfish I would say. (…) it is related to our individualism. (…) I think it is after renaissance when man is put on the center. I think it started there, to be honest." (E2)

"They learned to live like that. It is just natural to them, it is easy. It is just the way it is. Being sustainable is the opposite of what we have learned. The excuse isn't about not being sustainable. It is about being sustainable. Why do I need to be sustainable? Because everything else is teaching us otherwise. It is very comforting to have everything on your head to push an app and have someone deliver food to your house, not cooking at your home, that is very easy. Why should be people sustainable when it is so easy not to be?" (E3)

"Because we don't care. We think that it is not my problem, I didn't create this. I want to live my life as I want. Everything is ok so why should I bother or change my behaviour?" (E5)

Thirdly, the experts stress the importance of knowledge about the true impact of the simple choices we make in everyday life. For some experts, this is one of the main obstacles to sustainable behaviour. Experts believe that if people are aware of the negative impacts of their simple habits or actions, as well as the benefits of sustainability, they will make conscious choices. Main difficulty is being in the dark and uninformed.

The following sentences illustrate the results obtained:

"The problem is when you change the consumption habits, you buy sustainable products. But if you use more often the product, the sustainable benefits sometimes are not visible." (E1)

"I would consider that to be obstacle/objective to fulfill is, how you can make people definitely aware of their true impact of their choices." (E2)

"It brings us knowing something and then being able to consciously choose." (E2)

"People are not sustainable because they are not looking at the big picture." (E2)

"Not knowing the difference." (E4)

"If you as a producer or designer present some solution that is interesting or affordable, they will probably opt for that. But they need to know what they are doing. So, they need information to make the correct choice." (E5)

Another topic concerns false the perceptions of users, an issue that is directly related to the previous topic. People need to know the negative impact of their decisions and be aware of it. In this sense, having reliable information is vital. There are known cases in which people would like to perform the so-called sustainable behaviours and they were aware of their importance, however, they ended up causing other negative impacts. In this regard, experts gave some examples such as misunderstandings of some "sustainable" products or services: LAD lights, electric scooters, electric cars, and organic food.

The following sentences illustrate the results obtained:

"There is also some kind of mistakes in the perception of users. Sometimes people think that they have a sustainable behaviour. In fact, their behaviour is not so sustainable. And then you have another thing is important to consider. When you have more sustainable behaviour in some cases, the overall consumption is higher. For example, imagine a home with normal lamps and they consume x amount of energy, they want to be more sustainable and they changed to LAD light. So, the consumption ideally will reduce a lot. But in practice, in most of the cases that doesn't happen because they have the notion that since they are using LAD light, they can have the lights on much more time." (E1)

"Nowadays in the city you have a lot of scooters. That is good in the way that you have electric mobility available all over the city but what in the end happens is that some of the people that are using was walking before. They were doing exercise, and they were not wasting energy (...) We are trying to solve the problem, give more possibilities for users but we have some drawbacks." (E1)

"Organic in itself is not going to work obviously because organic is what we did. I mean initial farming was organic. We just put the seeds in the ground, it went up and done. You don't put a lot of things into the system to produce, so energy rises very low. But again, if things scale up, you need more so that process does not fit currently." (E2)

"We are always talking about electrical vehicles. Although the product itself has more impact on the environment than the non-electrical one. Because of the batteries, mainly.

We are thinking about electrical vehicles and change the paradigm but maybe it is not the best solution." (E5)

Finally, the experts highlighted the complexity of sustainability, a topic we also discussed earlier. To deal with this complexity of the sustainability as a random people or a designer in the field, was claimed as difficult.

The following sentences illustrate the results obtained:

"Have a way to present that complex information in a very straightforward way, very easy way." (E2)

"Everything is very complex like I have just said. Every decision that you are making whole bunch of little decisions, you may go to Celeiro (Portuguese health food store) to buy an organic food. But for instance, let's say that the lighting that they are using there doesn't come from renewable sources. Ok, I am buying organic but there is a whole bunch of other things, how about the people work in there? Are they being treated, being paid enough?" (E3)

In discussing the inherent complexity of sustainable behaviour and all the associated obstacles, it is important not being judgemental about people and primarily trying to understand them, so that we can focus on finding potential solutions. One expert stated that "it is very easy when you start to ask that why people are having unsustainable behaviours, it is very easy to go that road of morals and demonize people for their behaviours" (E2).

3.1.2.1.5 Fashion as a Barrier Breaker

We discussed the obstacles to adopt sustainable behaviour with experts. Then, we found it beneficial to talk about the possible forms of encouragement elements, which could take part as barrier breakers. Fashion was inserted into this discussion as one of the topics of interest for this research.

Most of the experts were of the opinion that fashion has the power to help overcome the identified obstacles. They all underlined the notion of fashion as "being part of something", "presenting oneself", and "having identity". Therefore, these results corroborate the possibility of fashion's power to change behaviours and convince people of something.

The following sentences illustrate the results obtained about fashion:

"Fashion is related to a life style the way you present yourself to the world. So, it has that huge impact, huge impact on how we perceive ourselves and how other people perceive us. So yes, definitely." (E2)

"Look at fashion; how fashion communicates, permeates society and try to see mechanisms that the use to convince people to do something to wear something. You could try to use that knowledge to your benefit; to change behaviour to something more sustainable." (E2)

"So that is everybody's turn to look beautiful, to make a name on themselves, to have an identity and being part of something, making a statement, right?" (E3)

"Human behaviour is very sensitive to appearances. (…) We are aware of what we interest, what kind of things that the rest represents, how we represent ourselves to others. So, in that sense, it is a very huge deal how can we change that peace of material of interest. In a way that it changes our behaviour. It is also one of the very difficult areas, because it is probably the fastest one." (E3)

Although not in the scope of this study, we also reflected on the fashion industry itself, briefly addressing topics such as how fast-based it is, how much high negative impacts causes and how it drives people to over-consume. One of the approaches discussed was about fashion system, which can change people's behaviour towards sustainable by shifting the business model of the system. Although this discussion is very important for sustainability, it is outside the scope of our study that aims to use fashion as a tool to promote sustainable behaviours.

3.1.2.2 Technology as a Barrier Breaker

The topic of technology was also discussed with the experts, in the same sense as the previous one. Most of the experts interpreted technology just like as fashion. They indicated that both fashion and technology have same potential power to help overcome the obstacles to sustainable behaviour. Moreover, technology has proven in the past that it can change behaviour. Smart phones, applications and constant Internet connection that came with it have completely changed the society that we live in today. It was also emphasized that were not only the physical smart products but also systems, like social media, to "create competitiveness" capable of alter lifestyles. All in all, if technology was able to change human behaviour before, it can easily change it now to a sustainable one.

The following sentences illustrate the results obtained about technology:

"Technology is a tool. I only see as that not the angle in itself, but a tool. I was talking about social media; it is impossible without technology." (E2)

"It is the same. Technology has taken the same path as fashion. Every brand needs to unravel a new product every year, every six months so it won't look like." (E3)

"I think technology has proven in the past that can change human behaviour. We can see in the gadgets, I-phones, and other things. The society has changed completely. Few years back, you see group of friends that are talking each other, now you see the same group and

they are all looking at phones and touching it. It is just an example. If it is possible to do that, in the sense of normal behaviour, that is possible towards a sustainable one. (E5)

3.1.2.3 Fashionable Wearable as a Barrier Breaker

After discussing fashion and technology with experts, we asked them about the potential power of fashionable wearables for this purpose. Even though fashion and technology were positively evaluated regarding behaviour change, the experts had some doubts about the role of smart clothes and other smart fashion products. Some experts suggested that "We should go simple" (E4) and wearables may not help to overcome obstacle to sustainable behaviour adoption.

However, health-related reasons for using wearables were found acceptable. It was claimed that heart beating measurements and other trackers that make life easier in what regards health, could be motivating. These examples can already be found in our everyday life, being strongly advertised by many companies. Therefore, it was considered easier to accept and to see the benefits of these wearables. But other future smart products are still developing; thus, they can also be considered acceptable when they become tangible.

The following sentences illustrate the results obtained about fashionable wearables:

"Not that I can see of it. But, if you tell me, if it's for health reasons, then of course I would approve. I will find it interesting and even cool. If a t-shirt tells me if my blood sugar is low, if my heart beating causes a risk, if I need to calm down or take pills, this is nice. So, yes if it is a health issue that is vital and makes my life easier." (E4)

"It can. Fitbit has a good gamification kind of thing. Every time you accomplish something, they send you an email like "you just do this and that…". Motivate you to do more and to what is going to be next. And we see that Nike has some cool apps to help you keep running and train. So, I think wearables are pretty good to be healthier. I don't know if sustainable but healthy." (E3)

Another doubt that arose was related to the consumption of yet another product, with an electronic interior, subject to rapid obsolescence, leading people to consume smart products that may bring negative impacts for sustainability. Among the examples given were problems with batteries and electronic recycling issues. However, for the most part, the experts agreed that the evaluation of the trade-offs will depend on the solutions and, thus, the benefits of the wearables could change. Therefore, they acknowledge that these solutions could have a positive impact on the environment and people.

The following sentences illustrate the results obtained about fashionable wearables:

"Yes. It might be expensive. But it depends on the solutions. (…) You have to think on the benefits and what might change." (E1)

"If that enables you to have access to information in real time in a very easy way about your choices, yes. Definitely." (E2)

"It can help. Those kinds of products are not sustainable. Like electric car. (…) Because you have another gadget with electronic, chemicals and rare metals that come from Africa or wherever and the battery issue and so on... But it can change our behaviour. So, throughout its lifecycle, it can have significant positive impact." (E5)

3.1.2.4 Research Question Discussion and Recommendations

We decided to end the interviews with the experts by discussing the main research question of our study. To this end, we asked them to give us suggestions or indicate any pitfalls that, based on their experience, we should avoid in the course of this research. However, this request did not offer us much help, as the experts mostly avoided developing this question much, answering things like "hard question", "it depends", "it is hard and very challenging", "it is a tricky question". However, the research topic was considered interesting and relevant.

Overall, the data obtained in this step suggests that the experts believe that this research question and overlapping areas are important and interesting enough to be worked on; however, in their opinion, they need to be well delimited, especially taking into account the specific sustainable behaviour, the wearable type, the features of wearable and of the system. The highlights of the discussion are listed below, accompanied by some example quotes from the experts:

1. Find a balance between technical solutions and consumption: Our research proposed the design of a fashionable wearable to promote sustainable behaviour. In this sense, although the intention is to promote sustainability, experts warned us that, if not well addressed, this project may end up contributing to the problem at stake in the sense that it supports the design of yet another fashion product, additional for consumption. Thus, experts suggested that we should find a balance about the situation and provide a way to minimize consumption of either the new version of the product or the product outcomes.

"It will be so easy for people to have new products every day, they will consume more. They will produce more. So, you have to have a balance between the technological solutions and the consumption. Of course, you can have a technology in clothes to minimize wash, you can

have technical materials that have some self-cleaning properties that you don't need to wash." (E1)

2. Add value and show benefits: Changing user behaviour was claimed as the most difficult thing to achieve in terms of sustainability. Therefore, people must see the benefit of the product, not only for sustainability but also for their own needs. Thus, experts consider that it is crucial that the benefits are very obvious and evident to users, otherwise the promotion of sustainable behaviour will fail.

"We have 2 options. One is force people to change, and that it is not working, or you can think about ways to add value for the users. If you add value in the direction of turn them in a more sustainable way, it will work. If you want to change consumer, you need to make sure that they benefit with it." (E1)

"Don't make something so that people buy it because it is cool but it is useful." (E3)

2. Do not force users and be judgemental: Not forcing the user was also stated in the previous highlight that it was not working. Assumptions about people in general related to the sustainability issue would not help. Therefore, the design has to encourage users unconsciously. Users have to be persuaded, and they need to be willing to be aware, informed, or accept. Eventually, the user should be in control, not the product.

"Don't be judgmental, don't judge people. Nobody likes to be judged. Don't force information, of course it has to be something that people are willing to accept." (E2)

"You can change unconscious part of ourselves. If it is something that you are demanding from us to do a conscious change, then that has some kind of effort." (E5)

3. Make it simple: Informing users and letting them decide was found crucial. Additionally, this information should be easy to obtain. The product or system should not be complicated or confusing for users to use.

"The problem for me is always the same, how you will convey that information to people in a very straightforward way." (E2)

"Some people who become aware, they try to change behaviour, but most of the time it is not a permanent change. So, it has to be an easy thing to do. It has to be a change that we do naturally." (E5)

4. Be careful how to integrate technology into fashion products: Experts considered that electronics in the fabric can be problematic and cause undesirable outcomes, such as being easily destroyed, causing additional electronic waste and being unhealthy for human beings in long term, for example on skin contact. Some suggestions were made, such as its use on

stand-alone/ independent accessories or modular garments, however, incorporating electronics into all clothing was not advocated.

"When you start to fuse different technology, you have to consider the lifecycle of the product, how it will end. The separation of electronics in fabrics can be something that is complicated. So, it depends a lot on how things mesh up or fuse which tends me to think about this in a more modular way. Something that is not necessarily dependent. (…) jewellery is a good example of that. Because you do not throw jewellery when you change your shirt." (E2)

"I would try to do something that is not fuse to the clothes in itself. It could be just a pocket." (E2)

5. Pay attention to the information you gather and use: The type, scope and tone of the information were emphasised as it should not disturb people but persuade them in a natural way. Information about the process and environment of manufacture could be shared with users to raise their awareness.

"Instead of only saying you should catch a bus, it might say think about leaving earlier and just walk there. (…) I think it is good to have that kind of melting in your head and helping you develop better habits, more sustainable habits for instance." (E3)

"It is pretty annoying all the buzzing and all that. But we also kind of used to it, don't we? How many notifications do we get on our phones every time?" (E3)

"You might have an interactive tag that tells you what it has been made, by who, from which sources. You can also find it in a paper of label with a QR code. (…) In clothes' case it might say you it is made with cotton or not, and supervise suppliers if it is children work." (E4)

6. Identify major impacts and find a specific area: The experts repeatedly stressed that sustainability is very broad, so the study should focus on a specific topic. Therefore, they suggested identifying the main negative behaviour-related impacts of everyday life to allow a focus on specific sustainable behaviour to change.

"You should think what is sustainable, it is the cloth, it is the item itself or it is the information that you are giving. (…) It is hard to work on everything. Are you working on the expectation of people, such as if they are informed well, they will change, or are you working on the technology on clothes that will be sustainable?" (E4)

"What kind of information that gadget gives us that will help us improve our daily routine, to know when the bus is coming, you need to find a specific area. Because like I said, sustainability is so large and very wide." (E5)

"I think you should identify the main impacts of our daily life and try to choose one or several, the ones are related or address the same thing. Either use of energy or the kind of

things that we eat... The mobility, now the chemicals we use, tooth brush, tooth paste, detergents… If you identify that the main impacts, and came from where, from what kind of behaviours/actions originate those impacts. For instance, main problem is climate change. It is related how our behaviour and use of energy. You need to identify what we do as a society and as a person that originate the problems." (E5)

3.1.3 Sustainable Behaviour Mapping

This section has been presented at the 6th Design Doctoral Conference: TRANSformation in Lisbon in 2019 and subsequently published in the journal "Convergências - Journal of Research and Teaching Arts" as: Ayanoglu, S.G.; Duarte, E.; Pereira, M. (2019). A Literature Review of Sustainable Behaviours Asserted in the Context of Everyday Life in Cities, Convergências - Journal of Research and Teaching Arts. XII (24), URL: http://convergencias.ipcb.pt (see Appendix R)

One of the first methodological steps was intended to clarify our understanding of what sustainable behaviours are. We tried to understand things such as, what kind of behaviours can be considered sustainable, which behaviours of city life can have a more negative impact, among others. We asked questions and discussed about these topics with experts in the expert interview step to inform our design decisions. The expert interviews resulted in a list of sustainable behaviour such as "Consume less, avoid the urge of 'I need everything'", "Reduce the need of buying", "To be aware, having a conscious, Knowing the impact", and "Try to be informed". However, these were considered too general. From this step, what we retained as most relevant was the importance of identifying the main impacts of everyday life and identifying the target behaviours, to limit/ narrow the research.

In parallel, we went looking for answers to the same questions in the literature review (which was presented in Chapter 2). Previous studies were found to have developed design strategies, theories, models and frameworks for influencing sustainable behaviour and lifestyles. Most of their approaches focus mainly focused on "how" to persuade users to behave in a certain way, mostly from the point of view of behaviour change models (Spencer, 2014) and mainly using the study of users' perception and psychology of users in order to persuade them. While important and significant to our research, these aspects have not closed the knowledge gap in our understanding which "type" of sustainable behaviours should be further explored. Arriving at this clarification would provide important basis for deciding the target sustainable behaviour on which we would find the best way to focus. This data would also help us find the way to match fashionable wearables with the identified behaviours.

Having completed the literature review and expert interviews, we carried out a mapping of the sustainable behaviours in the context of everyday city life, which are presented in this section. The "sustainable behaviour mapping" process was carried out in 4 steps:

Knowledge expansion and selection of publications: The following databases were selected for the systematic literature review: EBSCOhost, Elsevier, ScienceDirect, Google Scholar, OATD and the IADE Library bibliographic catalogue. The keywords used were: "sustainable behaviour", "sustainable lifestyle", "sustainable actions", "design for sustainable behaviour" and "design for behaviour change". Academic journals, conference materials, reports, books and dissertations/theses were the type of sources included.

After manual sorting, evaluating titles and abstracts, 41 publications were selected. Among these publications, and after analysing the alignment of the titles with the research objective, the availability of sustainable behaviours in the form of strategies, case studies, scenarios and the examples given in theoretical background, selecting one work by the same authors (directly proportional to the number of proposed behaviours), 10 publications remained (Table 15).

Table 15. List of sources

Sources	**Type of source**	**Brief topic**
(Akenji & Chen, 2016)	Report	Shaping sustainable lifestyles - Framework
(Thieme, et al., 2012)	Article	Designing a persuasive system to promote sustainable lifestyles – User study
(Bhamra, Lilley, & Tang, 2011)	Academic journal	Designing for sustainable behaviour - Case study
(Wever, van Kuijik, & Boks, 2008)	Academic Journal	User-centred design for sustainable behaviour – Case study
(UNEP, 2011)	Report	Recommendations to develop efficient, sustainable lifestyles based on the survey
(Petersson, 2016)	Report	Strategies to enable sustainable choices in everyday life – Guideline
(Monroe, 2003)	Academic journal	Encouraging environmentally responsible behaviours – Review / Theoretical Study
(Manning, 2009)	Report	Psychology of sustainable behaviour – Theoretical study
(Lidman & Renström, 2011)	Dissertation	Design for sustainable behaviour – Framework / Applied study
(Manzini & Jegou, 2003)	Book	Promoting sustainable everyday life by urban life scenarios – Framework / Case study

Review for framework selection: In order to do concept mapping for sustainable behaviour examples, we tried to found a framework that can best fit in the context. Existing literature on promoting sustainable lifestyles or everyday life was reviewed. 3 examples were found in the city context: Manzini and Jegou's (2003) sustainable scenarios in urban life, UNEP's (2011) Global Survey that examine young adults current lifestyles, and finally another UNEP report that propose enabling lifestyle choices that contribute to sustainability (Akenji & Chen, 2016). These studies were also discussed in detail in Literature Review Chapter.

Regarding these three approaches (Table 16), the main focuses were observed as daily activities inside home, eating habits and mobility. However, some dimensions were found unnecessary as they might be considered sub-elements under some proposed titles. Moreover, the fact of considering consumption as having a high impact on a daily basis, and leisure time activities were also important, as people spend considerable time as leisure.

Table 16. Findings of key domains based on different sources

Key Domains of Everyday Life	**Source**
Eating (food preparation) **Things** (taking care of the house and household objects) **Work** (the organization of activity networks for work, study, entertainment, socializing) **Cities** (urban mobility) **Energy** (energy production and management) **Vegetation** (the creation of urban and non-urban green spaces)	"Daily dimension of human's existence" (Manzini & Jegou, 2003)
Housekeeping (Being at home) **Food** (Getting some food and eating) **Mobility** (Getting around, getting out)	"Major climate-related areas" (UNEP, 2011)
Food (What we eat/drink, how it is produced, processed, provided and disposed of) **Mobility** (How/how often we travel) **Housing** (How/Where we live, what is used to build, heat and cool) **Consumer goods (**The type/quantity of products we buy, how we use and how often we replace) **Leisure** (How we spend leisure time, choice of tourism destinations, activities, how we use facilities)	"Key lifestyle domains" (Akenji & Chen, 2016)

Data collection, framing and content analysis: For our research, Akenji and Chen's (2016) approach was chosen as a framework, due to its recency, practicality and holistic point of view. This framework was not used only for proposing the domains of daily life, but also the

components of “everyday sustainability actions” (REDuse), which were formed as Refuse, Effuse and Diffuse (Figure 26).

Figure 26. The REDuse framework for sustainable lifestyles (Akenji & Chen, 2016, p. 28)

These components were used to categorize reviewed behaviour types considering sustainability. Also, lifestyle domains were renamed as “everyday life domains” and the behaviours found in previous cases that were not considered in any of these domains were framed as “Other”. After the decision of framework, the content analysis was made in literature and sustainable behaviour examples were placed in the frame.

Interpretation of results: After mapping sustainable behaviour examples by using the framework, we scored the frequency of suggestions that were gathered from selected 10 publications. The frequency of sustainable behaviour examples considering behaviour type and domains were illustrated. Based on the mapping and frequency chart, we made interpretations.

3.1.3.1 Concept Mapping, Analysis and Discussion

Framing different target sustainable behaviours, according to the selected framework, enabled a number of observations to be made (Table 17).

Table 17. Framed behaviour types and frequencies from the sources

Everyday Life Domains	***Refuse*** *Boycott, Avoid, Reduce*	***Effuse*** *Eco-innovate, Do-it-yourself Reuse, Conserve*	***Diffuse*** *Share, Collaborate, Localize Evo-innovate*
Food	Avoid food waste**** Distinguish the 'sell by', 'best before' and 'use by' dates (some foods are safe to consume even after use by dates* Avoid overconsumption of animal products (red meat)* Stop eating, selling, serving giant prawns* Reduce impact on global warming by not drinking heated beverages*	Choose local, fresh, in-season and/or organic produce over exotic and out-of-season options**** Urban gardening, urban farming, self-producing vegetables and fruits*** Eating more fruits and vegetables*	Initiate healthy, delicious and balanced low-impact meals at work canteen/schools* Participate in local farmers market* Support and invest in Food coop* Food sharing, extra cooking for others to take away** Guerrilla gardening*
Mobility	Avoid/reduce private car use; single-occupancy driving****	Public transport as part of or all the way to work** Walk or cycle for very short journeys such as the ones to local convenient store* Using bike in the city**** Using energy efficient vehicles**	Car-pooling scheme, car club*** Car-sharing for work commute*** Teleconferencing facilities instead of long-distance face-to-face meetings*
Housing	Avoid large houses (with low occupancy)* Avoid unnecessary product promotions/discounts* Avoid multiple/large electronic and electrical appliances (TV, fridges)* Reduce fridge door opening times* Reduce energy consumption****** Reduce household wastes* Switch-off the devices you don't use instead of stand-by*	Home insulation** Energy and water efficient behaviour**** Opt for renewable energy option** Construct "passive houses" (reduce building's eco footprint)* Use energy efficient light bulb* Recycling in the household* Correct dosing of cleaning agents (toothpaste, detergent)*	Initiate/join a (neighbourhood) tools library or rarely used household tools/appliances** Collective laundry washing in buildings* Organized help-network, do-it-yourself support* Neighbourhood co- operation/ exchange services*
Consumer goods	Avoid one-time use products (plastic bags, razors, plastic cups, single use cleaning products)* Stop buying goods that comes from slave labour* Stop buying goods that causes destruction of environment*** Use less washing detergent than recommended (safety margins)* Decrease the need for purchasing new clothes** Decrease amount of waste*	Repair* Recycle**** Purchasing green products based on degree of their environmental friendliness** Use reusable sanitary protection instead of disposable ones* Alter consumption habits* Reuse/repair clothes*	Give away old but still usable items (clothing, electronics, furniture)* Rent less-frequently used goods instead of buying*
Leisure	Boycott tourism to sensitive biodiversity hotspots*	Choose low impact yet enjoyable activities/experience for leisure (gardening, visit parks, local museums, theatre, cycling, volunteering, family	Participate events and courses for lifelong learning** Actively participate in leading environmental initiatives*** Be kind and caring to all living

		party/picnic)* Put up bird boxes* Plant sea oats* Re-use towels at hotels* Clean the beaches from rubbish* Keep streets clean/ nudging litter into the bin*** Look up information, reading articles/books*	things*
Other		Recycle papers and cups at work* Count wildlife populations* Promoting prescribed fire* Reduce waste in the production process*	Make voluntary donation to charities** Vote** Establish mortgage criteria for energy efficient houses* Sue a polluter* Use legal system to force compliance with environmental law* Protest, speech-making, letter-writing* Invest in environmentally responsible companies* Lobby to motivate others*
**The frequency of suggested behaviour*			

The following frequency chart (Figure 27) offers a graphic view of the different approaches grouped by everyday domain.

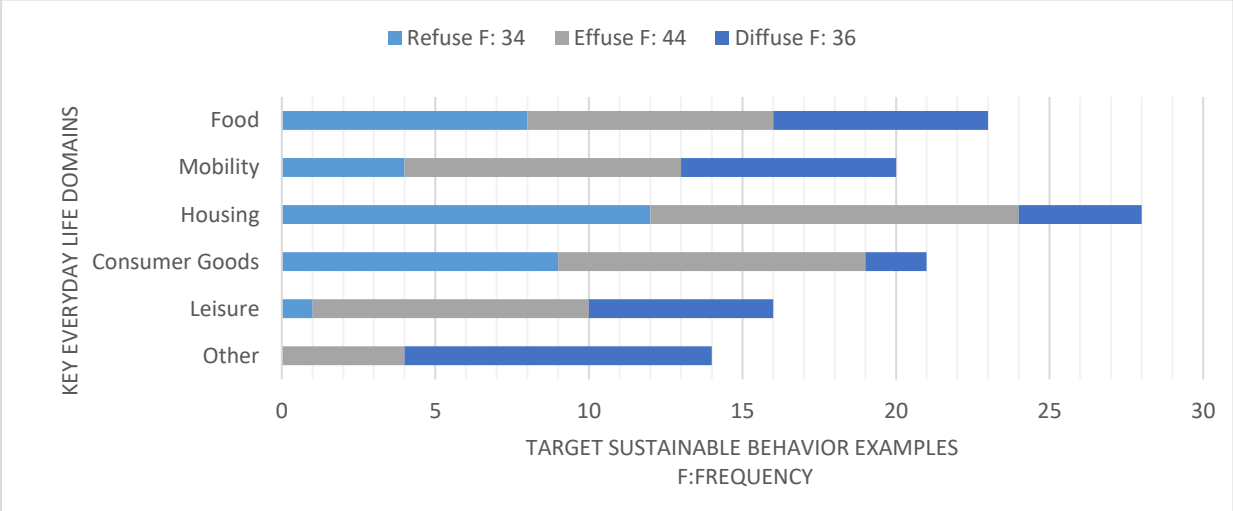


Figure 27. The frequency of target behaviour domains

Firstly, the data suggested that the largest number of target behaviours was found in the housing domain, especially in the form of refuse and effuse. In other words, collaborative forms of behaviours were less suggested compared to others. When examined in detail, mentioned behaviours were mostly related to energy consumption, such as: “switch off

devices", "reduce fridge door openings", "use energy-efficient light bulbs", and so forth. The next domains to be more frequently indicated were food, consumer goods and mobility. The domain of leisure activities and behaviours tagged as "Other", which were not considered in any of these key domains, were indicated as the least.

Secondly, the most suggested behaviours were: "reduce energy consumption", "avoid food waste", "choose local, fresh, in season and/or organic produce over exotic and out of season options", "use bike in the city", "energy or water-efficient behaviour" and "recycle". The majority of the frequently proposed behaviours were curtailing or ending a certain type of behaviour or substituting a new for an old behaviour.

Thirdly, the most suggested behaviours were found in the form of "effuse" behaviour, which are mainly summarized as more efficient and innovative solutions for a particular behaviour type, such as conserving, reusing, recycling or do-it-yourself suggestions. This demonstrated that the suggested target behaviours, which were also defined as sustainable behaviours, were proposed to promote more sustainable behaviour. Behaviours such as less goods consumption or less clothes purchasing were more efficient than recycling or repairing these artefacts, since waste was an unwanted output. However, both types of behaviour were considered sustainable, which could be understood in the sense that any kind of step towards sustainability was welcomed.

Fourthly, it was observed that some behaviours, such as "reduce energy consumption", "energy or water sufficient behaviour", "stop buying goods that cause environmental destruction", were being highlighted without clarifying a specific source or target, which might be considered vague. In contrast, some examples were clarified in generalized statements. For example, "Reduce fridge door opening" was focused on only one specific interaction with an industrial product instead of claiming "reduce energy consumption". Another example was "stop eating, selling and serving giant prawns", which puts a finer point on the "goods that cause environmental destruction" and specifically focuses on particular seafood.

Finally, some behaviours that were defined as "political behaviours" (Monroe, 2003) or "civic actions" (Manning, 2009), such as voting, protesting; "ecosystem behaviours" (Monroe, 2003), such as putting up bird boxes, planting sea oats; or behaviours specific to expertise or the workplace, such as reducing waste in the production process were categorized as "Others". Nevertheless, it was observed that behaviours were also related to energy

consumption, waste management or avoiding the destruction of the environment, which were similar topics in other domains of everyday life.

3.1.3.2 Section Conclusion

This part has explored and juxtaposed the understanding of sustainable behaviours through a content analysis conducted on the reviewed literature. Several studies were found presenting frameworks or seeking the answer on how to design, persuade, motivate, or encourage users to change their behaviour. We could gather examples of strategies, frameworks, or guidelines from them, which are suggested as suitable for this purpose. However, we also found many statements that do not clearly define the type of behaviour considered sustainable. Such vagueness therefore required a subjective interpretation that we based on product design features or case studies suggested in scenarios.

Identifying the mostly claimed behaviours as sustainable was the main intention of this part, aimed at supporting an informed decision on which behaviour(s) to select in order to design fashionable wearables. Based on the findings gathered, the research can now proceed to the next step, which is to collect users' perceptions on this problem. The domains of everyday life and the type of behaviour framing were considered for this identification.

3.1.4 Overview of Key Findings

Key findings from Phase One are demonstrated in the following Table 18.

Table 18. Results and outcomes of Phase One

Expert Interview Results/Outcomes:	**Sustainable Behaviour Mapping** Results/Outcomes:
1. Deepen the knowledge, justify and earn comments/ opinions about the proposed hypothesis. **2.** Highlights for the research • Find a balance between technical solutions and consumption • Add a value and show benefits • Do not force users and be judgemental • Make it simple • Be careful how to integrate technology into fashion products • Pay attention to the information you gather and	**1.** Domains of everyday life and type of behaviour framing demonstrated the majority of sustainable behaviour examples in the field of study. **2.** The domain of <u>housing, food, consuming goods and mobility</u> was the one with the highest number of identified behaviours. **3.** The most suggested behaviours were in the form of "**effuse**" behaviour, which is more efficient and innovative solution for a particular behaviour type such as conserving, reusing, recycling or do-it-

use • Identify main impacts and find a specific area **3.** The question of what kind of behaviours can be considered sustainable remained vague and unidentified. (Thus, a systematic literature review was needed to frame behaviours) **4.** Main unsustainable impacts were addressed as "overconsumption" by almost every expert. **5.** Experts supports behaviours targeting negative-impact activities/actions to avoid/reduce/**refuse** unsustainable practice. **6.** Most common examples on sustainable behaviours: • "Consume less / Reduce the need of buying" • "To be aware / Having a conscious / Knowing the impact" • "Try to be informed" • "Use bike / Bike-sharing" • "Use public transportation"	yourself suggestions **4.** The overall most suggested behaviours were: • "Reduce energy consumption" • "Avoid food waste" • "Choose local, fresh, in season and/or organic produce over exotic and out of season options" • "Use bike in the city" • "Energy or water-efficient behaviour" • "Recycle" **5.** Framework selection revealed the domains of highest negative impact behaviours in everyday life.

Expert interviews justified that behaviours such as owning fewer consumer goods or buying less clothes (REFUSE) are more efficient than recycling or repairing these artefacts (EFFUSE), as waste is an unwanted outcome. However, studies in the literature show that both types of behaviours can be considered sustainable, as any kind of step towards sustainability is valued. The conflict between the experts' suggestion of sustainable behaviours and those referred in the literature were analysed. Based on the findings, we decided not to focus on a single behaviour with the greatest negative impact on everyday life, but focus on one of the domains of everyday life containing types of behaviours that were commonly mentioned both in the literature and by the experts: Mobility.

The need for urbanization is addressed as "hope for a better life" (Eremia, Toma, & Sanduleac, 2017) and "hope to gain access" to necessities of life, knowledge, other people, and some other opportunities (Etezadzadeh, 2016). Access to all these necessities of life leads people to move around the city. Moving around the city, here understood as "mobility", is also one of the important pillars of smart city concept (Giffinger, et al., 2007) in the form of "smart mobility". It directly and locally affects the air quality and quality of life in terms of generating congestion, pollution and preventing freedom of accessibility (Sanseverino, 2014), which supports its importance.

According to the interconnection between the concepts, this phase ended with the choice of mobility decisions as the scope for our future design intervention, aiming at changing behaviours towards sustainability.

3.2 Phase Two: Discover

Based on the exploration of the context, understanding sustainability and identifying sustainable behaviours, we finally decided to focus on the mobility domain that has the highest negative impact on everyday life in Phase One. In Discover Phase, field research was conducted to explore user needs, obstacles (demands and problems) and underlying reasons that prevent users from adopting more sustainable behaviours under the choice of mobility. We conducted focus group interviews using various methods and tools such as card sorting, preference/satisfaction mappings, wants and needs analysis. Additionally, opportunity mapping was made to determine the opportunity of a particular mobility mode that fits better in the context.

3.2.1 Methods

The following methods were used in Phase Two:

Focus Group: Focus group is a technique involving the use of in-depth group interviews involving participants that are purposive, although not necessarily representative of a specific population, this group is requested to 'focus' on a given topic (Thomas, MacMillan, McColl, & Hale, 1995; Rabiee, 2004). This technique is widely used in social sciences for developing hypotheses in exploratory phases of research projects (Bloor, Frankland, Thomas, & Robson, 2001). Compared to other techniques, the interactive and synchronous group discussion aspect allows participants to discuss, agree, or dissent with each other's ideas and to elaborate on the opinions they have already mentioned (Nili, Tate, & Johnstone, 2017). Therefore, we assumed that this method would boost our understanding of user behaviour as well as the collection of different types of data, as well as testing underlying assumptions and research questions (Gailing & Naumann, 2018; Cyr, 2016).

There is no standard procedure for the evaluation of data collected in focus groups (Gailing & Naumann, 2018); however, the interaction between the participants is highlighted by various authors (Gailing & Naumann, 2018; Nili, Tate, & Johnstone, 2017; Onwuegbuzie, Dickinson, Leech, & Zoran, 2009). Thus, we conducted a tape-based analysis of both content and interaction data, which was collected in the form of verbal (words, sentences) and non-verbal (body language and facial expressions) expressions. The tape-based analysis is wherein the researcher listens to the tape of the focus group and then creates an abbreviated transcript (Onwuegbuzie et al., 2009). We opt for this type of analysis because it allows us to focus on the research question and only transcribe the portions that assist in a better understanding of the phenomenon of interest (Onwuegbuzie et al., 2009).

Card Sorting: Card sorting is a method used to generate an information architecture that refers to labelling and categorising information, organisation of structure and content (Baxter, Courage, & Caine, 2015). This method provides a quick and easy way to understand what matters most to people; furthermore, it can start a deeper conversation about user values and why (IDEO, 2015). For interaction design, research in social sciences, few investigating techniques are as effective as card sorting dealing with large numbers of concepts (Hudson, n.d.) which highlights the benefits of the method.

In our study, we preferred to use a closed card sort approach, in which "participants are given a set of cards and a set of pre-determined categories and asked to place the cards into those pre-existing categories" (Baxter, Courage, & Caine, 2015). We have created physical cards for representing modes of mobility and ask users to place them on a chart with two axes representing the level of preference and satisfaction. For the analysis, we created heatmaps with the data, which are a visual representation showing the position of cards on the determined chart. This method was used in a part of focus group sessions.

Opportunity Mind Mapping: Concept Mapping is one of the most effective ways to present findings and insights in one place and see the knowledge gaps and unknowns in the UX design process (Vasyukova, 2021). Opportunity mind mapping is defined as organizing aspects of the project and mapping opportunities for innovation (Kumar V. , 2013). Another form of mapping creates an overview and identifies possible opportunities organised over a common attribute. Our research identifies main topics from user problems and frames the insights to explore the opportunities of the chosen topics and related aspects. This process was

beneficial for the research to discuss and determine which topics on the map could be the most interesting and have the potential for further development.

3.2.2 Focus Groups

This section has been presented at the 10th International Conference Senses & Sensibility: Lost in (G)localization, in Lisbon in 2019 and subsequently accepted as a book chapter in publishing progress as: Ayanoglu, S. G., Duarte, E., & Pereira, M. (2021). User-Oriented Challenges of Smart Mobility: Using Focus Groups to Explore User Behavior. Springer Series in Design and Innovation. Springer. ISSN: 2661-8184 (see Appendix S).

This stage sought to answer the following question: "What are the obstacles that prevent users from adopting more sustainable behaviours in mobility choices?"

To better understand users' demands and problems, their preferences and satisfaction levels, as well as how they perceived the impact of smart solutions on their mobility choices, we organised this part into four main phases:

Knowledge expansion: We accomplished a literature review to understand state of the art about smart mobility systems, human behaviour, design for behaviour change and sustainability. These were all illustrated in previous chapters.

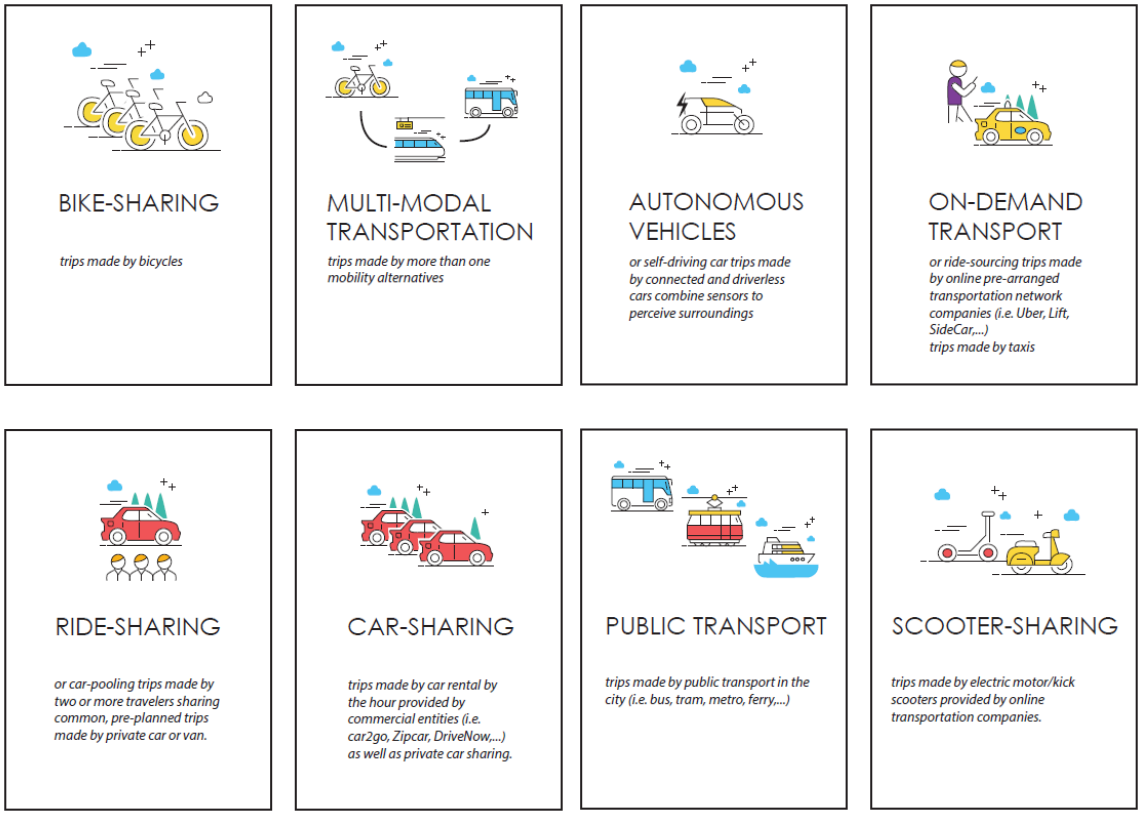
Planning and preparation: We determined the types of data to be collected and the criteria for their organisation according to the research objectives. We also prepared all the materials, forms, and procedures for the focus group and card sorting sessions (Appendix I). This phase also included a pilot test, which offered us the opportunity to make any necessary modifications/improvements before running the final sessions.

The focus groups sessions were structured into three phases and were held both within the IADE campus and in other locations in Lisbon, Portugal. Initially, we prepared open-ended questions targeting content and characteristics of the mobility system, the pillars of the mobility system, their experiences in Lisbon, and the comparison with other cities they lived before. The open-ended warm-up questions were as follows:

- Where are you from? How long have you been living in Lisbon?
- Did you live in any other cities before? If yes, which ones?

- How do you find Lisbon's transportation system? Can you compare it to the other cities you lived?
- Where do you mostly move around the city in your daily life?
- What is your definition of the best mobility system?
- Which mode of mobility do you use most often?

Secondly, a mixed card sorting was organised, focusing on both the context of current and future mobility systems. 10 cards representing "Modes of Mobility", were purposely designed for this study. In addition, empty cards were provided in case participants wanted to add more modes. The cards depicted current and planned modes of transportation, examples gathered from smart mobility projects, reports, and other sources, covering both motorised and non-motorised, public and individual means of transport (Perschon, 2012; Chow, 2018; Viechnicki, Khuperkar, Fishman, & Eggers, 2015; Reis, 2017). The ten cards (mobility options) shown were: (1) Walking, (2) Bike-sharing, (3) Public Transport, (4) Multi-modal Transportation, (5) Ride-sharing, (6) Autonomous Vehicles, (7) Scooter-sharing, (8) Car-sharing, (9) On-demand transport, (10) Personal cars (Figure 28).



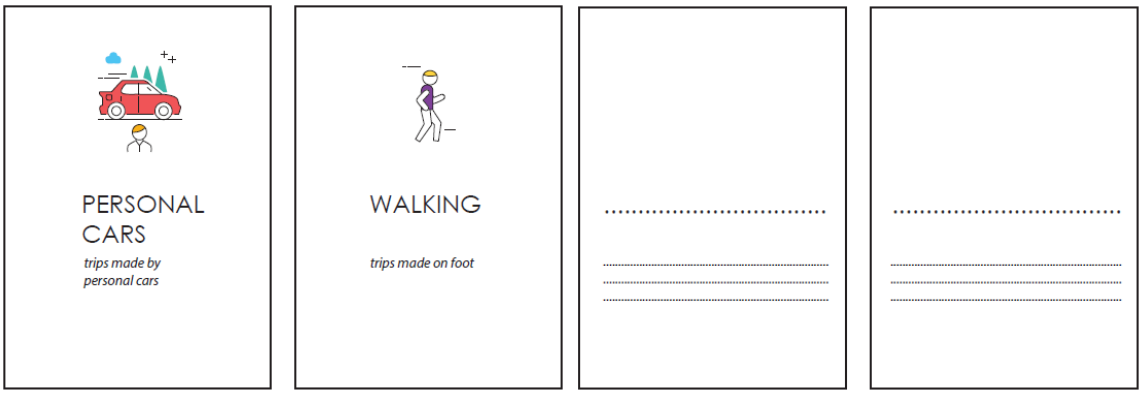


Figure 28. Modes of Mobility cards

We asked the participants to sort the cards on a chart divided into four quadrants by two axes representing the level of preference and satisfaction (Figure 29). At first, they were asked to sort the cards keeping in mind their current daily life and do it as a group. After, they watched the video about future mobility scenarios (Deloitte University Press, 2016) that includes all mobility modes and they were asked to, with that future scenario in mind, rethink the choice and positioning of the cards if they felt it necessary.

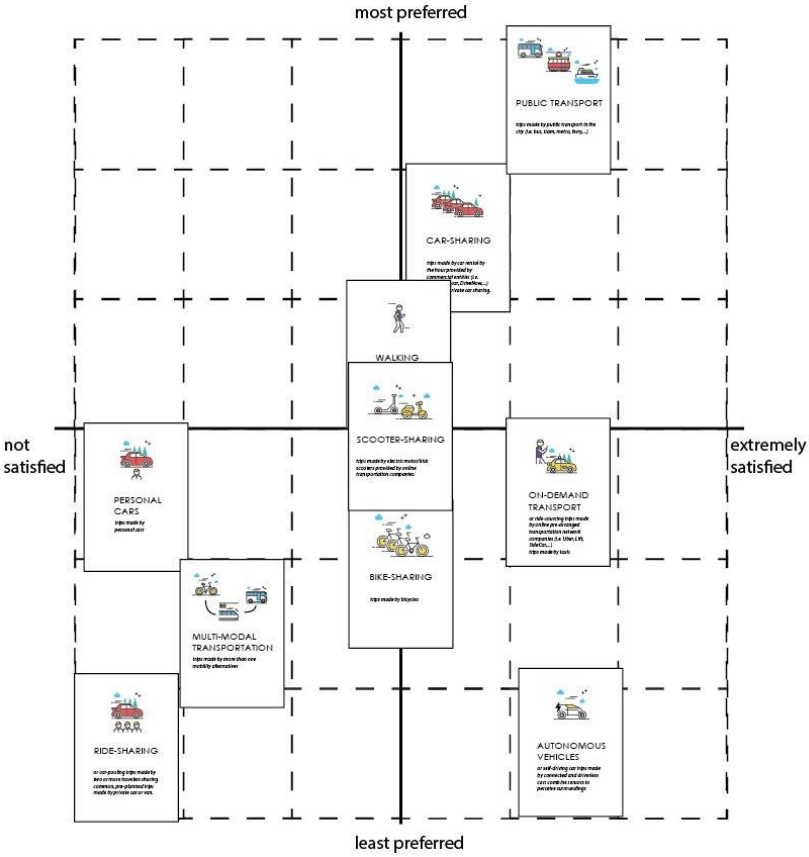


Figure 29. Preference/Satisfaction chart and random positioning of cards

We considered the future mobility scenario from Deloitte Insights to be the most suitable to illustrate the future mobility environment in smart cities (Figure 30). It consisted of a 3min 03s long video highlighting frictionless, automated, personalized travel on demand.

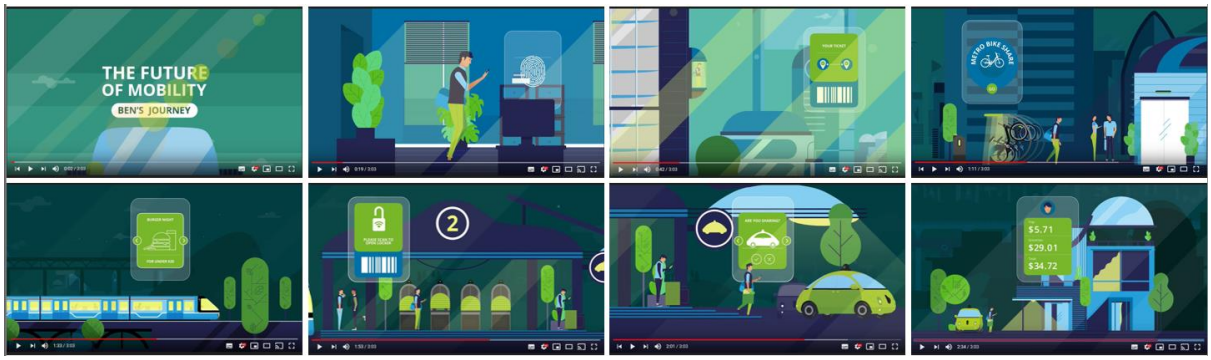


Figure 30. Scene screenshots from the video: "The future of mobility: Ben's Journey" (Deloitte University Press, 2016)

For the third and final phase, we prepared nine quotes defining random citizen approaches and common excuses that were collected from previous studies on behaviour change (Manning, 2009; Festinger, 1957; Solomon, Bamossy, & Hogg, 2006; Wendel, 2014) and asked potential users to interpret these quotes (Table 19).

Table 19. Quotes for the third phase

	QUOTES
1	"Kick scooters seems really convincing because of eco-friendliness and fun. But there are many brands. I am too lazy to download the app, to deal with QR code and to follow the steps."
2	"I prefer to use the metro so that I don't need to stuck in traffic but in rush hours, it is unbearable. I can't stand the crowd and noise after 9 hours of work."
3	"I would love to walk or use bike to work every morning since it is a very short distance. But weather is unpredictable sometimes. You went out in a short sleeve, and suddenly it gets cold, and you simply can't walk or cycle back to home. Plus, bikes are not really suitable for tight skirts and high heels; and I certainly wouldn't want to be sweaty at the office."
4	"I have to admit that I didn't use shared bikes in the city. I don't know how to use them. Do I need an app to download? I am kind of afraid if I make a mistake and cause them to charge more than my usage."
5	"Actually, if I had a car, I wouldn't mind sharing it. It's even interesting to find a chance to talk to some other people. Contributing environment and socializing at the same time!"
6	"I need a personal car. I mean it is how I get used to. Plus, you will never know when the emergency comes, and surely transportation options are not very tempting in some conditions."
7	"Sometimes I hate using more than one transport. You need to validate your ticket,

	check the times on apps to decide which option to choose. Apps are really helpful I have to admit but opening your backpack, finding your purse, taking out your pass, checking your phone… It may sound funny but it is hard! And imagine you have a shopping bag on your hand as well. Taxi, please!"
8	"I pay my taxes; I am hard-working and I do my best as a citizen. But people don't care about the pollution, the environment, the impact of their behaviours. Why should I be the stupid one and limit my lifestyle? Plus, I love to drive on my own."
9	"Sometimes I simply prefer to stay at home even though my friends invited me somewhere to meet. Well, I don't have a car. When I don't know where the place is and if it is far from my house, I usually come up with excuses."

Data Collection: The interpretations of the quotes were obtained through six focus group sessions (Figure 31), held with a convenience sample, composed by students and young adults that were currently living in different districts of Lisbon. The sessions were audio recorded and the transcripts were subsequently subjected to content analysis to assess the topics that gathered more agreement, support or disagreement among participants. The notes taken by the observer/moderator during the sessions were also considered.

Figure 31. One of the focus group sessions during the card-sorting phase

Data Analysis and discussion: We conducted a tape-based analysis for both content and interaction data, which were collected in the form of verbal and non-verbal expressions. This type of analysis allowed us to focus on the research question and only transcribe the parts that help to better understand the phenomenon of interest (Onwuegbuzie et al., 2009). A content analysis conducted with MAX Qualitative Data Analysis (MAXqda) software, provided us

with data about on how often some keywords were mentioned by the participants (Appendix J, K). Heatmaps were created with the data gathered from the card sorting, which are a visual representation showing the most selected (hot areas) and less selected (cold areas) quadrants in which the cards were positioned by the participants, after and before video-watching phase.

3.2.2.1 Demographics

A convenience sample comprising 29 volunteers participated, which were distributed by six independent focus groups (six groups with five participants each and one group with just four participants due to a last-minute impediment from one participant).

Table 20 shows the sample demographics. The age of the participants ranged from 18 to 31+ years old. Most of the participants were female (82,8%), with ages comprised between 21 and 23 years old (41,4%), single (62,1%), and college students. Although most were Portuguese (48,3%), 10 different nationalities participated, allowing the comparison between their former experiences in different cities and Lisbon.

Table 20. Participant demographic profiles distribution

Value	F	%	Value	F	%
Gender			**Civil Status**		
Female	24	82,8%	Married	11	37,9%
Male	5	17,2%	Single	18	62,1%
Age			**Nationalities**		
18-20 years old	6	20,7%	Portuguese	14	48,3%
21-23 years old	12	41,4%	Brazilian	6	20,7%
24-26 years old	3	10,3%	Spanish	2	6,9%
27-29 years old	3	10,3%	Turkish	1	3,4%
30-32 years old	3	10,3%	Salvadorian	1	3,4%
33 years old and older	2	6,9%	Russian	1	3,4%
Professional Status			French	1	3,4%
Student	21	72,4%	Dutch	1	3,4%
Employed	5	17,2%	Mozambican	1	3,4%
Student and employed	3	10,3%	Romanian	1	3,4%
Total (∑)	29	100%	*Total* (∑)	29	100%

F: Frequency / %: Percentage

3.2.2.2 Demands and Problems of Users

The contents collected during all three phases of focus groups were analysed to identify demands and problems related to mobility systems. As Table 21 shows, 15 topics were obtained for the demands and 19 for the problems.

Demands: The demands were identified mainly from the analysis made of the answers to questions such as: "What do you want from a mobility system?" and "What does the best mobility system must have?". Additionally, we examined the conversations and interactions, looking for complaints and why the participants claim they prefer a specific mobility mode, disregarding others. We gathered the keywords and phrases.

The most referred demands were: "convenient price", "frequency", "safety/security", "space" and "speed". In short, these results suggest that users demand "cheap" or "free" transportation, with a frequent schedule, in which "people should be able to sit" or, at least, one that is less crowded so that they do not have to "crush or push people". They would like "to go from point A to B in the fastest time possible".

Problems: Regarding the problems, safety, security and reliability were the most mentioned issues. According to the participants' opinions, the mobility systems are not safe as they should be, encompassing both the robustness and reliability of the mechanical components and the associated technology and embracing the payment process and the quality of the maintenance. Regarding security, the participants declared they do not always trust people, referring, in many cases, to the driver or the other people co-sharing the vehicle with them. Other less frequently mentioned topics were the poor quality of the information provided on how to use the transport system. Participants state they need clear and reliable information to avoid/reduce difficulties in understanding the routes and timetables. They also say that they often doubt the information provided is updated and/or is accurate/valid. The "Sustainability" topic was also raised during the focus groups; however, in a low percentage, suggesting that sustainability was not a hot concern or demand for them.

Table 21. Participant demographic profiles distribution

Topics: Demands from mobility	**F**	**%**	**Topics: Problems of mobility**	**F**	**%**
Convenient Price	58	13,36	Security/Trust	68	12,08
Frequent	57	13,13	Time	65	11,55

Secure	49	11,29	Demand Additional Preparation	56	9,95
Enough Space	37	8,53	Cost	46	8,17
Fast	34	7,83	People Density/No Space	42	7,46
Punctual	30	6,91	Frequency	35	6,22
Convenient Routes	29	6,68	Facilities	34	6,04
Comfortable	26	5,99	Confusing	26	4,62
Easily Reachable	26	5,99	Lack of Option	25	4,44
Reliable Information	22	5,07	Comfort	24	4,26
Clear Information	20	4,61	Digital App	24	4,26
Offer Efficient Facilities	18	4,15	Lack of Route	23	4,09
Sustainable	14	3,23	Personal Space	20	3,55
Maintained/Repaired	10	2,30	Personal Excuses	19	3,37
Clean/Hygienic	4	0,92	Traffic/Parking	17	3,02
			Maintenance/Regulations	11	1,95
			Weather Conditions	11	1,95
			Lack of Information	8	1,42
			Hygiene	6	1,07
			Sustainability	3	0,53
Total (∑)	*434*	*100%*	*Total (∑)*	*563*	*100%*

F: Frequency / %: Percentage

The statements below reflect the general perspective of users, which mainly refer to safety/security issues in using/sharing a given transport mode:

"For me, everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. I know that rape and harassment are not common here, but still, I would never take these options (sharing) in any circumstances."

"I am kind of afraid of car sharing, I can crush a car that's not mine."

"The only reason why I won't choose autonomous vehicles that I'm scared that something might go wrong. So public transportation is my choice, I mean, there's also a possibility that I'll crash there, but at least, I'll have somebody to follow."

"As a woman, I wouldn't prefer it (ride-sharing)."

"I don't feel safe in Uber. Sometimes because of the driver and sometimes because of the payment method. They take me from a long distance."

"I don't want a stranger in my car."

"Drivers don't like bikes on the road, they hate it."

Statements related to “time” concerns were also frequently indicated. Associated with this issue, we could find some concerns with the lack of confidence in apps that, ac-cording to them, provide little credible information about timetables. In cases where the user needs to reach somewhere quickly, personal cars or on-demand transport, which were less sustainable options, were chosen immediately. The statements below illustrate the participants’ time concerns.

“I use it every day. The apps are accurate mostly but sometimes it just doesn’t work. Or it says five minutes. You wait, and then the bus appears, you realize that thirty minutes passed.”

“I work in Carnaxide and to get there is terrible. It’s 15 minutes by car but it’s 1,5 hours by bus. If my car breaks down, I’ll cry.”

“I don’t want to wait 40 minutes; I'm not going to be here (bus stop) forever.”

“Big issue about walking is the time that it takes.”

“You need to download (the app for scooter), put your card number, then discover how the thing works. It takes time.”

“If I really need to go somewhere quicker, I think I would call for Uber.”

Users claimed that some modes of mobility which “demand additional preparation” before the usage cause demotivation. The need for validating tickets, waiting on queues, the necessity of choosing appropriate apparel, additional payment, downloading different brand’s digital applications were the mostly stated complaints:

“Coming to work on a bike you have to wear very comfortable clothing like sneakers, shorts, t-shirts. Sometimes you have meetings where you have to dress up so you'd have to have a place where you can put your clothes.”

“Sometimes I just want a green line, without using transport cards, validation on gates or buses. It would be so good.”

“I go to university with my computer and lots of other stuff, I can’t ride a bike with them.”

“I already pay for public transport, why am I going to pay for bikes or scooters additionally?”

“You don’t have a helmet and you can be in the middle of the cars so it’s dangerous. No one is walking with helmets.”

“I don’t want to change my clothes, to carry other clothes, and change it. It is so hard (for biking).”

"Too many brands (scooter) confuse. I don't have the time to actually research and stuff."

“If you don't have a (transport) card, you can pay to the driver but there must be a system that you should be able to pay with your credit card directly inside.”

The complaints regarding the “cost” of mobility were frequent, as the price of the rides was the primary concern of users. However, the cost was not as relevant as the other issues raised by the participants. The results suggest that if the choice was secure, fast, and did not require any extra action, the price could be considered acceptable or could be negotiated. The statements below illustrate the participants’ concerns with price/cost.

> *“It'll be great (autonomous vehicles) but it also depends on the price. If they had some kind of systems like the public transport that you pay monthly and a lot cheaper, I would definitely use them.”*
>
> *“Sometimes it (scooter) can get more expensive than picking on-demand transport.”*
>
> *“I think public transportation should be almost free or free. Transportation is a right for everyone.”*
>
> *"It doesn't make sense to me that there are zones and the price is changing. I can't afford to live in the centre and I have to pay more than the people who can afford to live in the city centre. With one ticket you should go everywhere."*

Another issue that was frequently mentioned was the poor availability of public transports given the high demand, especially at the rush hours, which results in over-crowding, causing discomfort and affecting people’s choices.

> *“Rush hours are very crowded. I have to stand and I am small, so I have to travel with arm-pits around me.”*
>
> *“It’s so full that you cannot even get inside (bus).”*
>
> *“The anxiety when you need to get out of public transport, but you cannot because of people. It is too crowded so you have to crash or push people.”*
>
> *“There was one time I almost faint.”*
>
> *“Bus is not always great because it is crowded and uncomfortable, there is no place to sit, you just stand up and it shakes a lot.”*

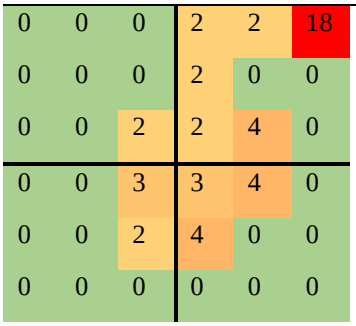
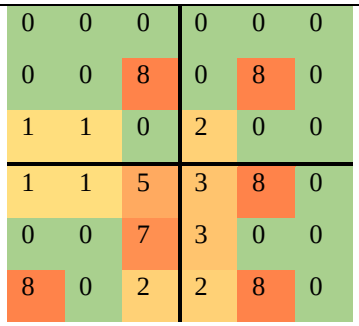
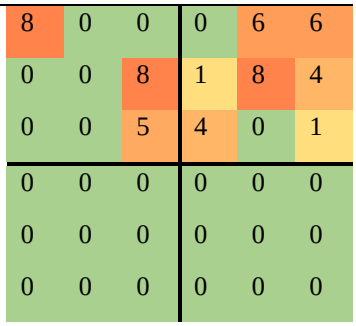
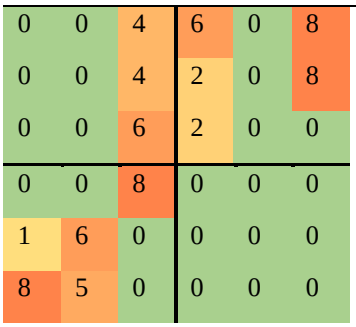
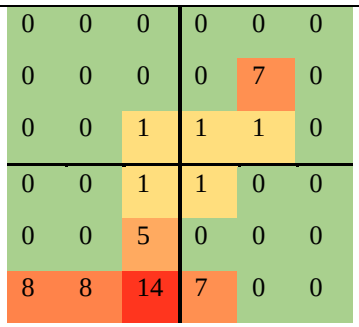
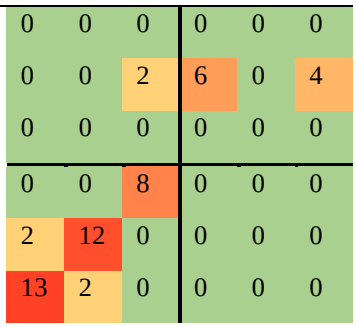
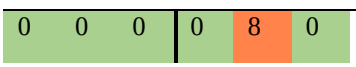
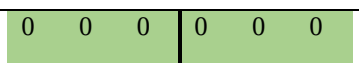
Other assorted problems, which could also be subject of improvement, were the number of alternative options available and their convenience, namely in terms of the routes available that do not always cover the entire city or require a complex combination of alternate transports to get to specific destinations. Some participants also found the information systems (e.g., maps, timetables, signage) confusing and not as inclusive as they should be. Overall, “Hygiene” and “sustainability” topics were the least mentioned problems.

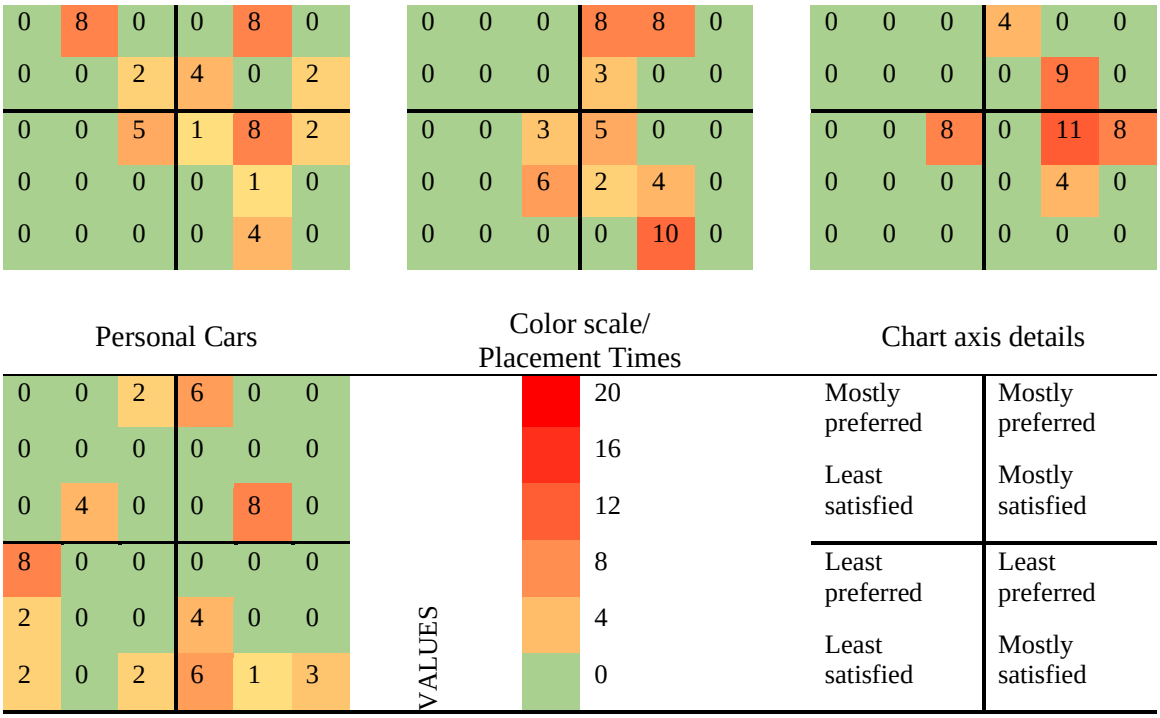
3.2.2.3 Preference and Satisfaction Levels about the Modes of Mobility

To analyse the results gathered in the card-sorting phase, we used a heat map, which provides a visual representation of the users' preferences and satisfaction levels. The heat map was created considering the number of cards positioned by the participants in the diverse regions of a map drawn by us, which was divided into four quadrants, employing two-axis representing preference and satisfaction.

We created heat maps per each participant and group in two distinct moments: 1st considering the current experience with the transport systems, and 2nd anticipating future experiences of use after watching the smart mobility scenario video. Table 22 shows heat maps representing the overall placement of cards.

Table 22. The heat maps of overall card placement

Walking	Bike-sharing	Public Transport
		
Multi-modal Transportation	**Scooter-sharing**	**Ride-sharing**
		
Autonomous Vehicles	**Car-sharing**	**On-demand Transport**
		



Overall, the heat maps suggest the users were extremely satisfied and moderately preferred the "On-demand Transport". They seem to prefer primarily the "Public Transports" and, secondarily, the "Multi-modal transportation systems". However, they were moderately satisfied with these options. The "Walking" mode attained a high preference level, and was participants were slightly more satisfied with it than with the other options.

The "Sharing" modes were the least satisfactory and the least preferred. Users were not satisfied with these options and barely preferred "Ride-sharing" and "Scooter-sharing". This trend worsens when looking at "Car-sharing" and "Bike-sharing", which were the least preferred options, with poor satisfaction levels. The placement of "Autonomous Vehicles" and "Personal Car" cards were very divergent. Without further data, we cannot state the reason for this result, but we can speculate that the indecision may be due to contradictory opinions about personal cars and, in the case of autonomous vehicles, the absence of previous experiences with this type of vehicle.

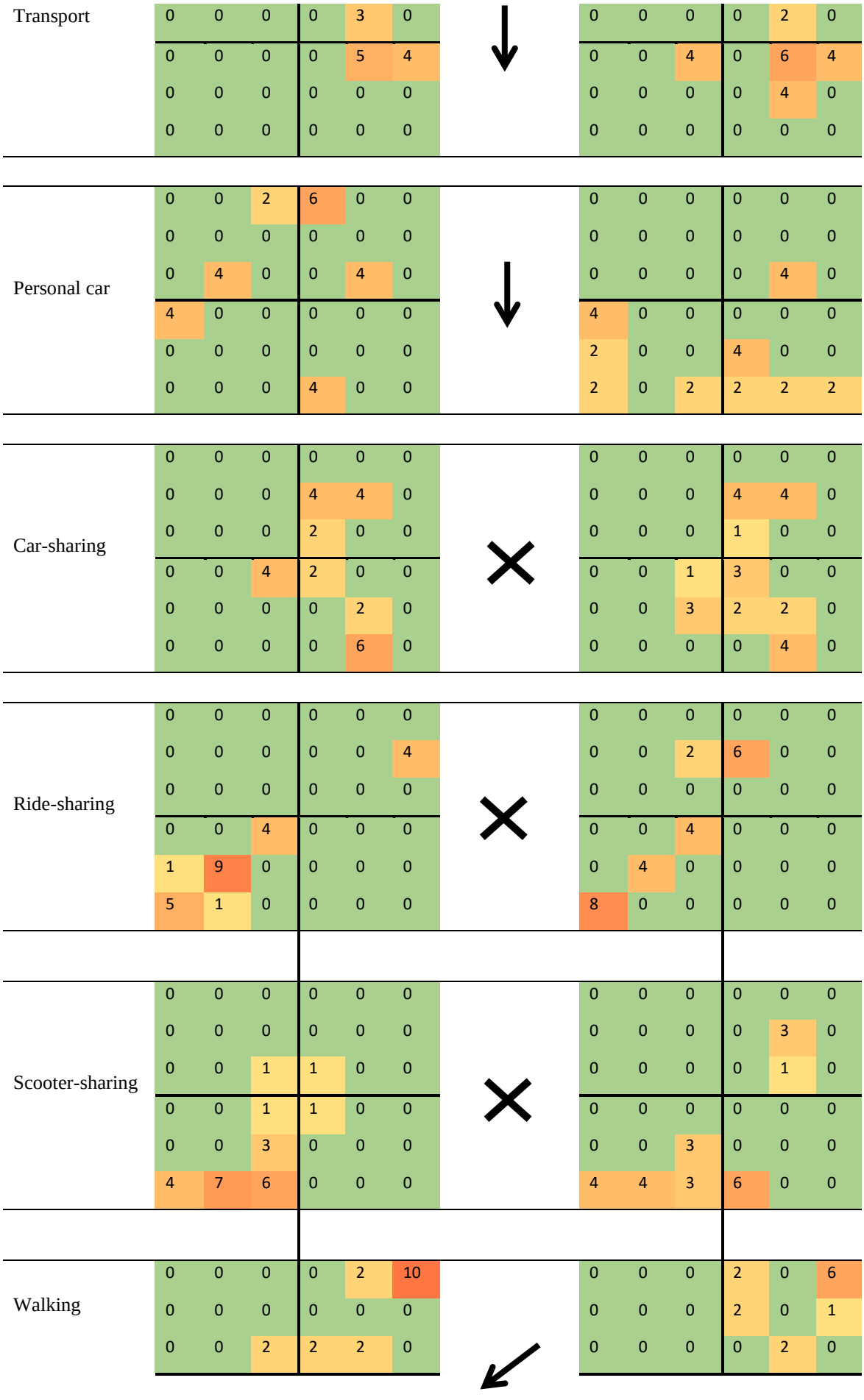
3.2.2.4 The Impact of Smart Solutions on expectations about the Mobility System

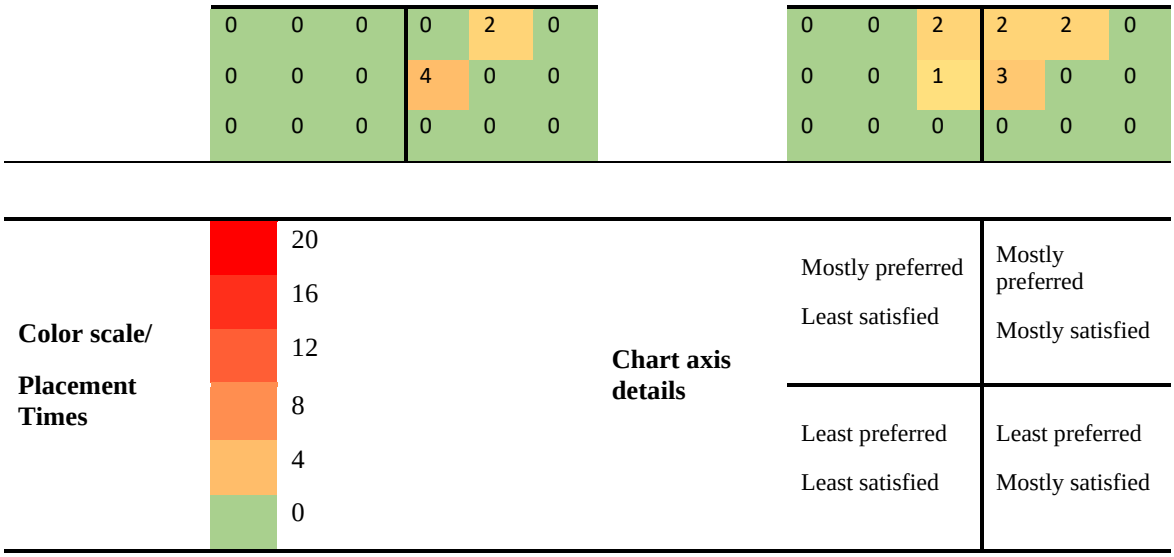
As said before, we requested participants to revise their cards placement after watching a video about smart mobility solutions (Table 23). The intention was to show them a glimpse of

a future scenario of mobility within smart cities and collect their anticipated user experience about it.

Table 23. The heat maps of card placement before and after video-watching

	Heat Maps of Card Replacement																	
Modes of mobility	**Before Video-watching**							**Replacement shift**	**After Video-watching**									
Multi-modal Transportation	0	0	0	1	0	0			0	0	4	2	0	4				
	0	0	1	1	0	8			0	0	2	0	0	0				
	0	0	1	1	0	0			0	0	5	1	0	0				
	0	0	4	0	0	0			0	0	1	1	0	0				
	0	6	0	0	0	0			0	0	0	0	0	0				
	4	2	0	0	0	0			4	0	0	0	0	0				
Autonomous Vehicles	0	0	0	0	0	0			0	0	0	0	8	0				
	0	4	0	0	4	0			0	0	0	0	4	0				
	0	0	1	1	0	0			0	0	0	4	0	2				
	0	0	5	1	4	0			0	0	0	0	4	2				
	0	0	0	0	0	0			0	0	0	0	0	0				
	0	0	0	0	4	0			0	0	0	0	0	0				
Bike-sharing	0	0	0	0	0	0			0	0	0	0	0	0				
	0	0	0	0	0	0			0	0	4	0	4	0				
	1	1	0	0	0	0			0	0	0	2	0	0				
	1	1	5	1	0	0			0	0	0	2	4	0				
	0	0	5	1	0	0			0	0	2	2	0	0				
	4	0	0	0	4	0			0	0	2	2	0	0				
Public Transport	8	0	0	0	4	0			0	0	0	0	2	6				
	0	0	4	0	4	0			0	0	4	0	4	4				
	0	0	2	2	0	0			0	0	2	2	0	0				
	0	0	0	0	0	0			0	0	0	0	0	0				
	0	0	0	0	0	0			0	0	0	0	0	0				
	0	0	0	0	0	0			0	0	0	0	0	0				
On-demand	0	0	0	0	4	4			0	0	0	4	0	0				
	0	0	0	4	0	0			0	0	0	0	0	0				


Transport
0 0 0 0 3 0
0 0 0 0 5 4
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 2 0
0 0 4 0 6 4
0 0 0 0 4 0
0 0 0 0 0 0
Personal car
0 0 2 6 0 0
0 0 0 0 0 0
0 4 0 0 4 0
4 0 0 0 0 0
0 0 0 0 0 0
0 0 0 4 0 0
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 4 0
4 0 0 0 0 0
2 0 0 4 0 0
2 0 2 2 2 2
Car-sharing
0 0 0 0 0 0
0 0 0 4 4 0
0 0 0 2 0 0
0 0 4 2 0 0
0 0 0 0 2 0
0 0 0 0 6 0
0 0 0 0 0 0
0 0 0 4 4 0
0 0 0 1 0 0
0 0 1 3 0 0
0 0 3 2 2 0
0 0 0 0 4 0
Ride-sharing
0 0 0 0 0 0
0 0 0 0 0 4
0 0 0 0 0 0
0 0 4 0 0 0
1 9 0 0 0 0
5 1 0 0 0 0
0 0 0 0 0 0
0 0 2 6 0 0
0 0 0 0 0 0
0 0 4 0 0 0
0 4 0 0 0 0
8 0 0 0 0 0
Scooter-sharing
0 0 0 0 0 0
0 0 0 0 0 0
0 0 1 1 0 0
0 0 1 1 0 0
0 0 3 0 0 0
4 7 6 0 0 0
0 0 0 0 0 0
0 0 0 0 3 0
0 0 0 0 1 0
0 0 0 0 0 0
0 0 3 0 0 0
4 4 3 6 0 0
Walking
0 0 0 0 2 10
0 0 0 0 0 0
0 0 2 2 2 0
0 0 0 2 0 6
0 0 0 2 0 1
0 0 0 0 2 0



Results reveal no significant differences in participants' preferences and satisfaction on most of the sharing possibilities: "Scooter-sharing", "Car-sharing", and "Ride-sharing", with the exception of "Bike-Sharing" which we could observe a positive shift. Without further data, we cannot say with certainty whether people continue to have doubts about these modes of mobility, even when they are presented in apparently perfect working condition (i.e., without most of the problems previously identified) or if the scenario presented was not credible enough to affect their assessment. Nevertheless, "On-demand Transport" and "Personal Car" preference levels got lower, which could be considered a positive change in favouring sustainability. Plus, users were more satisfied and willing to adopt "Public" and "Multi-Modal" transportation modes. Overall, this suggests, at least to a certain degree, that people are sensitive to changes regarding their mobility decisions if the system can offer a good user experience all over the journey. However, we also observed that "Walking" became the least preferred and least satisfactory option, losing terrain against less sustainable options.

3.2.2.5 Section Conclusion

This part of the Phase Two was about understanding users' behaviours and the obstacles that may prevent them from engaging in sustainable mobility modes.

Understanding the uses of future smart and sustainable mobility system represents a great challenge for design, as it implies imagining a context that does not exist yet and that will serve as a reference for all the design decisions we will make in this respect.

While always involving a considerable degree of uncertainty, it is likely that the best evaluated solutions (i.e., those that achieve a better anticipated user experience) may be the most successful, regardless of their sustainability degree. By identifying the users' concerns and demands, their biggest complaints and the problems they judge as more relevant, which can hinder their daily commute, this research aimed to provide informative data for designers and other professionals in different fields to develop future mobility solutions.

The present findings point to some of the most relevant demands and problems about mobility modes, which we think need to be addressed appropriately when designing future mobility systems. The results also show that a future smart city, at least one that fits the scenario showed, can have both positive and negative impacts on users' mobility choices. Options that are currently being suggested as good choices for sustainability, such as "sharing" mobility modes, were not appealing to users regardless of future smart possibilities. Furthermore, the improvement of the overall transportation quality negatively affected the attractiveness of "Walking", which is the most advocate mode for non-motorised sustainable mobility.

Although topics related to "sustainability" were mentioned as mobility demands and stated as a problem that has to be solved, the frequency with it was brought into the conversation was very low compared to other topics. This suggests that sustainability in mobility may not yet be a major concern for people. Thus, researchers, designers, and experts in related fields concerned with sustainability cannot currently count with much support from users. Which highlights the need to conduct more design for behaviour studies, like this one, in an attempt to change the current preferences and expectations to pave a better path for introducing innovative solutions successfully.

Mobility is an important requirement for social and economic development and the current mobility culture is unsustainable (Perschon, 2012). While smart mobility systems, smart cities, and IoT possibilities create several potentially beneficial visions for our society, the power to choose and use these options is owned by people. Thus, benefiting from the results obtained so far, the next phase should be to strengthen users' preference and satisfaction levels. However, it is also clearly seen that there must be an initial step before the next phase. Since we found various problems and demands related to all modes of mobility, we found it necessary to identify the specific mobility mode to work on.

3.2.3 Opportunity Mind Mapping

The previous part of Phase 2 provided us with a range of users problems and demands. In this part, we reanalysed the users' problems by mapping them and identifying the opportunities for possible target behaviours or mobility modes. The opportunity mind mapping step of the second phase was carried out in 4 phases, as follows:

Identifying key dimensions and core topics: In this first phase, we reanalysed the quotes tagged under 20 topics of problem. In the initial analysis, verbal and non-verbal data were counted under problem topics and frequencies were calculated. Quotes that were supporting similar content were removed. Thus, we eliminated some user quotes based on similarity and those consisting of approval phrases. We organised them with respect to problem topics and in some cases, they were related to more than one topic.

First elimination was made with respect to problem topics that were overlapping (Table 24). Within 20 topics of problems, we eliminated half of them which were only related to transportation/mobility system itself. However, problem quotes that had overlapping topic were kept. The future mobility concept would be offering solutions for problems related to the transportation system. The scope of this study was not about proposing technical solutions in the field of smart mobility or urban planning, as such, these topics were eliminated.

Table 24. Considered and eliminated topics

Considered/chosen topics:	**Eliminated topics:**
Security/Trust	Time
Demand Additional Preparation	Cost
Facilities	People Density/No Space
Confusing	Frequency
Digital App	Lack of Option
Personal Space	Comfort
Personal Excuses	Lack of Route
Weather Conditions	Traffic/Parking
Lack of Information	Maintenance/Regulations
Sustainability	Hygiene

Mapping core topics and related aspects: The basic structure of the map was created by deciding important topics and related aspects whose existence was considered beneficial

(Table 25). We grouped user quotes that came from different focus groups (tagged as F1, F2, …). Then, these were framed by problem topics, insights, target sustainable behaviour, possible user needs, and possible wearable solutions, apps, interface or other smart system component might offer.

Table 25. Content mapping with one grouped quotes example

SELECTED FINDINGS FROM FOCUS GROUPS - PROBLEMS (QUOTES)	**PROBLEM TOPIC(S)**	**INSIGHTS**	**CAUSE (negative impact behaviour)**	**TARGET (sustain-able behaviour)**	**POSSIBLE USER NEEDS**	**FEATURES/ SOLUTIONS**
F1. Everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. **F1.** I can share with people that I know, that's okay but if I have to share with strangers, I wouldn't do that. **F5.** It is a bit security issue. I don't want stranger in my car. **F4.** I wouldn't like even if it's cheaper or eco-friendly, sharing is tricky.	security/trust issue, personal space issue	user doesn't trust people/ doesn't feel secure, doesn't want to share. Even the cost is not important.	no ride-sharing, no car-sharing	share ride, share car, share autonomous vehicles	-to know the person who will be shared. -to have information about the shared person. -Easily reach the security/police. -To be able to share the location to others. -To be able to pick the other user.	APP: Select users/evaluate users WEARABLE: Panic buttons (textile) that call police or share location
…	…	…	…	…	…	…

Refine the map according to the attributes: Initial mapping demonstrated various opportunities on defined problem topics that we still found too much to focus on (Figure 32). Thus, in this phase, we returned to previous phases of the main research and reviewed the literature for the second and final elimination.

Selected findings from Focus Groups - Problems (quotes)	Problem Topic(s)	INSIGHTS	CAUSE (negative impact behaviour)	TARGET (sustainable behaviour)	POSSIBLE USER NEEDS	features/solutions
F1. Everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. F1. I can share with people that I know, that's okay but if I have to share with strangers, I wouldn't do that. F5. It is a bit security issue. I don't want stranger in my car. F4. I wouldn't like even if it's cheaper or eco-friendly, sharing is tricky.	security/trust issue, personal space issue	user doesn't trust people/doesn't feel secure, doesn't want to share. Even the cost is not important.	no ride-sharing, no car-sharing	share ride, share car, share autonomous vehicles	to know the person who will be shared. to have information about the shared person. Easily reach the security/police. To be able to share the location to others. To be able to pick he other user.	APP: Select users/evaluate users WEARABLE: Panic buttons that call police or share location
F2. When you share the car, you have this uncomfortable feeling like you have to talk. F4. Sometimes I just feel like, I just want to go school, I don't want to talk. F3. It's nice to share but I don't like it. I like my personal space. F6. I don't even share my car with my mum. It becomes your personal space and sometimes you store things inside. F6. Also, when somebody is driving your car, they need to change some stuff inside, rearrange them which is annoying. F2. Sometimes, you just need some silence and want listen to my music. F3. I tried some time but it's always stressful. Because you might be a person that don't mind to get late. And lateness is really bothering me.	personal space issue	user wants personal space. User store or arrange things in personal car and doesn't anyone else to change it. User need silence and/or choose to listen their own music. User doesn't want to wait for others.	no ride-sharing, no car-sharing	share ride, share car, share autonomous vehicles	Obligation to return the default settings inside the vehicle. Easily personalize the vehicle. To be able to listen the preferred music. To be in silence. Not to wait for others.	APP issues? Personal space* Share game/competition
F6. Drivers don't respect bikers. F5. And Lisbon has lots of hills and no special road. So, bikes are not suitable. F6. If there were bike roads, I might feel safer. F3. In small cities you can easily walk or use tram. So I think it depends on the city. F4. Some cities are designed for cars, so it's very hard to walk over because of the cars everywhere.	security/trust issues, lack of route, frequency issue, lack of option issue,	user is scared of/doesn't trust disrespectful drivers, scared of crash, user cannot find suitable routes for bikes and walking.	decrease in usage of bike, decrease in walking		to trust traffic while they are on feet or bike, to be informed about the incoming car or other threats, to have specific roads for bikes, scooters. To have enough and safe pavement for walking. To feel safe while walking or biking	WEARABLE motion sensor/vibration that car, people, bike coming, lights on clothes that catch attention
F1. If the distance is short, bikes are good. It's not suitable for all clothes and also if we have to carry some stuff (bike). F2. Once I decided to go work by bike. I tried 3 times and then I gave up. Sometimes things happen like, today I want to wear skirt, today I want to wear sandals... F3. I could bike from home to work. It's 10 km but how smelly I would get when I go there?	**demand additional prep issue**, comfort issue	if user need to carry extra clothing for the mobility, need to be prepared for the trip, they mostly choose simpler choice. User doesn't want to think about dressing for the mobility mode. They don't want to exercise that cause sweat before going to target point.	decrease in usage of bike		to have a clothing that can cover multiple exercise conditions, to have a modular clothing that can change or transform into desired way, to have clothes that have resistant to sweat or makes you less sweat, to have suitable places in bikes that you can put your belongings without carrying it.	FASHIONABLE WEARABLE design, modularity, changeable modules, sleeves, collars..
F2. One day it's raining a lot and the other day it's sunny but there's one percentage of chance of rain, then ok no bike. F3. Walking would be fine because you can use umbrella. F6. The weather needs to be good for biking. F6. I think it depends on the weather if it's not cold or rainy, I might walk from Rossio to here.	**demand additional prep issue**, weather issue	weather conditions effect the choice of mobility. User doesn't want to use bike or walk in bad weather conditions such as cold or rainy. However if there's a solution to get avoid the problem (umbrella) they might choose sustainable options.	decrease in usage of bike, decrease in walking		to have a clothing that can cover resist in multiple weather conditions, to have solutions for getting cold or getting wet.	MATERIAL CHOICE, water repellent fabric, wearable/app that shows weather WEARABLE: embedded heating system
F3. Where am I going to put it (bike) and you'll be charging. F4. I think one thing that drove me away from this was not having enough places to put it. I could use this for going from the metro to school, but there is no bike station close to here. F3. If I can find bikes everywhere and leave anywhere I want, I might prefer it more.	security/trust issue, costing issue, confusing, lack of option, facilities issue	user has difficulty in finding bike stations, bike-sharing options are confusing and they afraid of being overcharged, they want more bike stations close to target point.	decrease in usage of bike		to be informed about the possible bike stations and how to deal with the bike and the app. To go to target place without feeling any anxiety such as where to park or where to find bike-stations. To have a better organized bike-sharing system.	best option to park, alert with WEARABLE
F1. I have to catch bus and the metro. Unless I have pockets in my jacket, I always carry the pass on my hand. F4. I put my transportation card back of my phone. F6. When you have a backpack it's hard to arrange things on gates. F3. I think it would be better to have everything free, everything open and have more people doing the job instead of the gates. Every time I go into metro, I need to wait for the queue to charge my card. F6. Sometimes I just want a green line, without using transportation cards, validation on gates or buses. It would be so good. F5. If you don't have a card, you can pay to the driver but there must be a system that you should be able to pay with your credit card directly inside.	**demand additional prep issue**, facilities issue, timing issue, people density/no space issue	user needs to use an external product to benefit from a particular transport system. They need to find the transport card, or put it in insecure places such as pocket, back of phone. They need to wait in gates while using the transport or charging the card. they ask for different options for payment.	decrease in public transport, decrease in multi-modal transport		to precharge their cards in multiple places or online, to pay other ways if they miss the card, to have another options rather than transport cards, to use the transportation systems freely without waiting and loosing time.	WEARABLE validation by fabric (chips, qr code, nf code on textile)
F1. It is really boring because you have to take it (jacket) off and put on and take off again if you're changing transport. F1. It is really cold on streets so you put a lot of jackets and then you enter to bus and it's too hot. F1. There shouldn't be a shocker temperature. It's really important, too. F6. Sometimes it is crazy inside of the buses because of the air conditioning.	**demand additional prep issue**, weather issue, facilities issue, comfort issue, people density/no space issue,	user doesn't want to change clothes, put lots of layers. User wants proper air conditioning systems inside of transport.	decrease in public transport, decrease in multi-modal transport		to have a clothing that can change or transform into desired way, to have clothes that have resistant to sweat or makes you less sweat.	system possibility WEARABLE heater fabrics
F1. I agree that there are lots of scooter brands and I'm lazy to download the apps F4. having too many brands causes confusion. I don't have the time to actually research and stuff. F5. You need to download, put your card number, then discover how the thing works F3. Even if I would want to try one, I never did because you install an app. And then you get somewhere and there's a different brand.	**demand additional prep issue**, confusing, digital app issue, timing issue	user doesn't want to loose time while figuring out a system. User wants a holistic transport system that covers all.	decrease in bike-sharing, decrease in scooter-sharing		simplicity in bike/scooter sharing apps, not to loose time to understand, simpler interfaces, other possible options to use bike/scooter brands	APP possibility / app for all brands - access with fabric
F3. In Lisbon you have metro, buses, train and it's pretty good. It's not bad if there's no strike. F6. Sometimes there's lack of information. For instance, they say the train will be late but you cannot see it from anywhere before getting inside of the gates.	facilities issue, lack of information	user wants in advance information	increase in on-demand		to have an in advance information through different channels	system APP option/ WEARABLE: shows the late news, delays, strike, traffic accident...
F1. Maybe sometimes you are just lazy to walk to the station or the major station F5. Who likes to walk?	personal excuses	user doesn't want to walk, lazy, doesn't like, not motivated enough.	decrease in walking, increase personal car		to have a motivation for unwanted mobility choices, gamification, rewards. To understand the benefits, to experience it for a while to understand that it is not hard, harming or difficult.	WEARABLE listening music option on fabric, APP gamification, collecting points and gaining rewards..
F2. I think use of car is also cultural F3. My mom never used public transportation. So, since I have my driver's license, I don't use public transportation. I just take my car.	personal excuses	user thinks that it's cultural, educational issue, related with habits, routines	increase in personal car, decrease in public transport, decrease in bike-sharing		to have an education, information if not in family, To understand the benefits, to experience it for a while to understand that it is not hard, harming or difficult. To see the results of sustainable choices.	APP that shows the improvement (congrats! You walked x km this week, earn ticket to z play in theatre)
F2. It's a line between like doing my part for the environment and limiting my lifestyle. It's very blurry. F5. We are having trouble changing our lifestyles	personal excuses,	people are indecisive about the situation. They are in need of motivation.	general demotivation		to see that this is not limiting the lifesyle, improving it.	APP options, free trials
F1. If we have 2 buses that pass from our bus station, one that is eco-friendly and one is not, I would prefer eco-friendly	sustainability issues	people are not against enviromental choices, they simply need sustainable	general demotivation		to continue theit habits in the same way with sustainable options, they don't want to sense	two options should be same, clothing should not be different from the ones that we are using

Figure 32. Overview of initial mapping

As we mentioned in Literature Review Chapter, Perschon (2012) recommended potential strategy responses for sustainable mobility as avoiding, shifting and improving particular transport types (no travel, non-motorised, public-motorised and individual motorized) (Table 26). Regarding the previous phase's outcomes, such as sustainable behaviour examples in everyday life domains and experts' suggestions, we decided to focus on two non-motorised transport modes: Walking and Bike-sharing. Ultimately, target sustainable behaviours were selected as: "Increasing the choice of walking and bike-sharing".

Table 26. Mobility modes and types strategy

Smart Mobility Modes	Reference suggestions (Perschon, 2012)	Target Behaviour
(1) Walking	non-motorised	increase
(2) Bike-sharing,	non-motorised	increase
(3) Public Transport	public-motorised	increase
(4) Multi-modal Transportation	public-motorised	increase
(5) Ride-sharing	individual-motorised/ public-motorised	
(6) Autonomous Vehicles	individual-motorised/ public-motorised	
(7) Scooter-sharing	non-motorised	
(8) Car-sharing	individual-motorised/ public-motorised	
(9) On-demand transport	individual-motorised	decrease
(10) Personal cars	individual-motorised	decrease

Analysing the map and discussing opportunities: Finally, we framed problems, cause of problems, insights, target sustainable behaviour (walking or bike-sharing), possible user needs, and possible smart solutions in a more detailed manner.

3.2.3.1 Analysis and Discussion

Table 27 demonstrates the mapping of opportunities. By opportunity we mean a situation or condition favourable for attaining a goal. The objective was to find the potential problem topic and target behaviour to guide further concept development. The opportunity mind mapping shows the notes taken under the core topics that were structured in the process.

We had seven clustered problem quotes belonging to different topics. All quotes shared multiple problem topics except “personal excuses” topic. Personal excuses topic has two clustered quotes: one that was related to “walking”, in which users simply claimed that “Who likes to walk?” and the other was related to the choice of personal car, which was found “cultural” or just simple decision without giving a second thought. In addition to these two clustered problem quotes, there were others. One of the grouped problem quotes were related to bike roads and car drivers. They claimed that there were no specific roads for bikers and car drivers didn’t respect bikes. Therefore, they were afraid to use bikes and possibly that would be the reason for not preferring them. The other group of quotes were supporting that biking needed additional preparation before usage, such as an appropriate clothing or the need of changing clothes because of possibility of sweating. Another group was also in the same topic but with different considerations, about the weather conditions. Biking would need

additional preparation because we never know on weather might change during the day. This issue was also counted for walking. The other group of phrases were related to bike-sharing possibilities. They claimed that the problems were not knowing where to park and not finding a closer place around the target destination. Final group was related to the applications, especially in scooter-share; however, that could also be interpreted as bike-sharing problems. The issue was confusing applications and interfaces, different brands demanding different information and extra effort to use. All clustered quotes from users were evaluated under the topics shown in Table 27. These solutions were in the initial phase and simultaneously we worked on possible technology solutions that might fit in these initial ideas.

Table 27. Opportunity mind mapping

SELECTED FINDINGS FROM FOCUS GROUPS - PROBLEMS (QUOTES)	**PROBLEM TOPIC(S)**	**INSIGHTS**	**CAUSE (negative impact behaviour)**	**TARGET (sust. behaviour)**	**POSSIBLE USER NEEDS**	**FEATURES/ SOLUTIONS**
F6. Drivers don't respect bikers. F5. And Lisbon has lots of hills and no special road. So, bikes are not suitable. F6. If there were bike roads, I might feel safer. F3. In small cities you can easily walk or use tram. So, I think it depends on the city. F4. Some cities are designed for cars, so it's very hard to walk over because of the cars everywhere.	security/trust issues, lack of route, frequency issue, lack of option issue	user is scared of/doesn't trust disrespectful drivers, scared of crash, user cannot find suitable routes for bikes and walking.	decrease in usage of bike, decrease in walking	Increase the usage of bike, increase the choice of walking	to trust traffic while they are on feet or bike, to be informed about the incoming car or other threats, to have specific roads for bikes, scooters. To have enough and safe pavement for walking. To feel safe while walking or biking	WEARABLE motion sensor/vibration that car, people, bike coming, lights on clothes that catch attention
F1. If the distance is short, bikes are good. It's not suitable for all clothes and also if we have to carry some stuff (bike). F2. Once I decided to go work by bike. I tried 3 times and then I gave up. Sometimes things happen like, today I want to wear skirt, today I want to wear sandals… F3. I could bike from home to work. It's 10 km but how smelly I would get when I go there?	demand additional prep issue, comfort issue	if user need to carry extra clothing for the mobility, need to be prepared for the trip, they mostly choose simpler choice. User doesn't want to think about dressing for the mobility	decrease in usage of bike	Increase the usage of bike	to have a clothing that can cover multiple exercise conditions, to have a modular clothing that can change or transform into desired way, to have clothes that have resistant to sweat or makes you less sweat, to have suitable places in bikes that you can put your belongings without carrying	FASHIONABLE WEARABLE design, modularity, changeable modules, sleeves, collars…

		mode. They don't want to exercise that cause sweat before going to target point.			it.	
F2. One day it's raining a lot and the other day it's sunny but there's one percentage of chance of rain, then ok no bike. F3. Walking would be fine because you can use umbrella. F6. The weather needs to be good for biking. F6. I think it depends on the weather if it's not cold or rainy, I might walk from Rossio to here.	demand additional prep issue, weather issue	weather conditions effect the choice of mobility. User doesn't want to use bike or walk in bad weather conditions such as cold or rainy. However, if there's a solution to get avoid the problem (umbrella) they might choose sustainable options.	decrease in usage of bike, decrease in walking	Increase the usage of bike, increase the choice of walking	to have a clothing that can cover resist in multiple weather conditions, to have solutions for getting cold or getting wet.	MATERIAL CHOICE, water repellent fabric, wearable/app that shows weather WEARABLE: embedded heating system
F3. Where am I going to put it (bike) and you'll be charging. F4. I think one thing that drove me away from this was not having enough places to put it. I could use this for going from the metro to school, but there is no bike station close to here. F3. If I can find bikes everywhere and leave anywhere I want, I might prefer it more.	security/trust issue, costing issue, confusing, lack of option, facilities issue	user has difficulty in finding bike stations, bike-sharing options are confusing and they afraid of being overcharged, they want more bike stations close to target point.	decrease in usage of bike	Increase the usage of bike	to be informed about the possible bike stations and how to deal with the bike and the app. To go to target place without feeling any anxiety such as where to park or where to find bike-stations. To have a better organized bike-sharing system.	best option to park, alert with WEARABLE
F1. I agree that there are lots of scooter brands and I'm lazy to download the apps F4. having too many brands causes confusion. I don't have the time to actually research and stuff. F5. You need to download, put your card number, then discover how the thing works F3.	demand additional prep issue, confusing, digital app issue, timing issue	user doesn't want to lose time while figuring out a system. User wants a holistic transport system that covers all.	decrease in bike-sharing, decrease in scooter-sharing	Increase the usage of bike, increase the choice of walking	simplicity in bike/scooter sharing apps, not to lose time to understand, simpler interfaces, other possible options to use bike/scooter brands	APP possibility / app for all brands - access with fabric

Even if I would want to try one, I never did because you install an app. And then you get somewhere and there's a different brand.						
F1. Sometimes you are just lazy to walk to the station or the major station F5. Who likes to walk?	personal excuses	user doesn't want to walk, lazy, doesn't like, not motivated enough.	decrease in walking, increase personal car	increase the choice of walking, decrease the choice of personal car	to have a motivation for unwanted mobility choices, gamification, rewards. To understand the benefits, to experience it for a while to understand that it is not hard, harming or difficult.	WEARABLE listening to music option on fabric, APP gamification, collecting points and gaining rewards..
F2. I think use of car is also cultural F3. My mom never used public transportation. So, since I have my driver's license, I don't use public transportation. I just take my car.	personal excuses	user thinks that it's cultural, educational issue, related with habits, routines	increase in personal car, decrease in public transport, decrease in bike-sharing	decrease the choice of personal car, increase in public transport, increase in bike-sharing	to have an education, information if not in family, to understand the benefits, to experience it for a while to understand that it is not hard, harming or difficult. To see the results of sustainable choices.	APP that shows the improvement (congrats! You walked x km this week, earn ticket to z play in theatre)

3.2.4 Overview of Key Findings

Key findings from Phase Two can be observed in the following Table 28.

Table 28. Results and outcomes of Phase Two

Focus Groups Results/Outcomes:	**Opportunity Mind Mapping** Results/Outcomes:
1. Majority of the demands from mobility system: "convenient price", "frequent", "secure", "enough space" and "fast". **2.** Majority of the problems: "Security/Trust", "Time", "Demand Additional Preparation", "Cost", "People Density/No Space"	**1.** Considered problem topics were selected: • Security/trust • Demand Additional Preparation • Facilities • Confusing • Digital App • Personal Space

3. Even though "sustainability" topic were mentioned as demands from mobility and asserted as a problem that must be solved, the frequency was very low compared to other topics. Sustainability in mobility is not the main concern for people. **4.** Preference and satisfaction mapping (before and after video-watching): • No significant difference in Scooter-sharing, Car-sharing, and Ride-sharing. • Bike-Sharing preference and satisfaction were observed as it shifted slightly towards the positive x and y-axis. • On-demand Transport and Personal Car preference levels got lower. • Users became more satisfied with Public Transport and Multi-Modal transportation. • The quality of transportation as a system positively affects people. However, Walking became the least preferred and least satisfied. **5.** Problems and demands were too general and vague. (The need for focusing on target mobility)	• Personal Excuses • Weather Conditions • Lack of Information • Sustainability **2.** Target mobility modes were selected as: Bike-sharing Walking **3.** Target sustainable behaviours were selected as: "Increasing the choice of walking and bike-sharing".

In this phase, we conducted focus groups to find out more about users' problems and demands, preferences and satisfaction levels to illustrate the obstacles and provide a basis for ideation of solutions. These obstacles raised a number of topics that later caused a need for reducing and providing more effective solutions. One of the focus group phases provided visual support for users with future mobility scenarios where the smart mobility system functions appropriately. This part was essential to explore the impact of smart mobility solutions on users' mobility choices. Improving the quality of transportation positively affected people. However, we also observed that Walking became the least preferred and least satisfied one after seeing the quality of the system, which could be considered less sustainable. Another non-motorized transportation Bike-sharing preference and satisfaction were observed as it shifted slightly more preferred however not satisfied enough. Other "sharing" types of modes are not appealing to users regardless of future mobility possibilities.

As a final step in this phase, we made an opportunity map to reanalyse and evaluate the problems of users as well as other potential of the mapped opportunities. We discussed and determined which mobility modes and target behaviours on the map were most interesting and best fit for further development. Initially, topics were too general and vague, related to all

modes of mobility. We decided to concentrate on enhancing the preference and satisfaction levels of non-motorized mobility by finding possible solutions to user problems. Benefiting this phase's results, another important decision of target sustainable behaviour was selected as "Increasing the choice of walking and bike-sharing".

3.3 Phase Three: Conceptual Design

The main objective of this phase is developing relevant, innovative ideas and concepts around the target behaviours that were set to be to increase the mobility choice of walking and bike-sharing in Phase Two. In this phase, we first created personas and problem scenarios based on users' profiles, demands, and needs and selected problem quotes. Secondly, we generated concept ideas not only based on problem scenario but also product requirements and strategies for behaviour change. Finally, we evaluated and finalized conceptual design by expert evaluation.

3.3.1 Methods

The following methods were used in Phase Three:

Personas: Personas are fictional archetype characters created to represent a group of users of a specific artefact or system. These personas are grouped in specific user classes, have needs, goals, motivations, limitations, as well as a work role or sub-role, generated based on data gathered from contextual data (Hartson & Pyla, 2012). In the User Experience (UX) design process, personas provide insights into "real" behaviours of "real" users and help resolve conflicts that arise when making design (Unger & Chandler, 2012). As an initial step for this method, user personalities need to be defined for exploring concepts around them (Kumar V. , 2013). The number of personas required for a project depends solely on how different the users within the focus area are. It could be two, four, or six but usually not more than six to avoid difficulty distinguishing them from one another (Nielsen, 2019).

In our study, we created three personas in the goal-directed perspective of Alan Cooper, which is "an efficient psychological tool for looking at problems and guide for the design process" (Nielsen, 2019). Basically, our persona shows attitudes, motivations, goals and frustration. The goal of the persona is the fulfilment of the wants and needs.

Scenarios: Scenarios are descriptive or pictorial stories of the users or personas to show how users might act to achieve a goal in a system or environment (Interaction Design Foundation, n.d.). These stories are beneficial to bring users to life during product development, to understand their motivations, needs, barriers and more (Courage & Baxter, 2005; Interaction Design Foundation, n.d.). Furthermore, scenarios are used in a variety of situations and, most commonly, usability testing and ideation of new ideas (Salazar, 2021).

In our study, we used scenarios focused on the challenging situations that our personas face, mainly for ideation and conceptual design development. Scenarios are usually centred around one task that includes an actor, a motivator, an intention, an action and a resolution (Salazar, 2021). We used three personas as actors carrying out the scenarios with the intention to go to some place. During that process, they are confronted with some problems related to our target mobility mode. In this case, our scenario illustrates a day story in which three personas meet at some point, then separate, and the story resolves. Designating different categories for ideation is also suggested while setting up scenarios (Salazar, 2021; Courage & Baxter, 2005). Ideation categories could be design ideas, questions, comments or considerations. We also added these categories when we created visual frames of the created scenario.

Storyboarding: A storyboard is a sequence of visual frames illustrating the interplay between a user and an envisioned system, and it brings the design to life in graphical clips (Hartson & Pyla, 2012). Storyboards are also interpreted as an example of low-fidelity prototyping that is often used in conjunction with scenarios (Preece, Rogers, & Sharp, 2002) and help visualize concepts from start to finish (IDEO, 2015). A storyboard is a beneficial presentation tool but mostly not self-explanatory; therefore, it can be combined with texts that explain each frame and tell the story (Moritz, 2005).

In our study, we designed storyboards to explain better the narrative scenario that we created before. Speech balloons and external explanation texts were also used in frames for a clear explanation. Since we had a visualised scenario, we find the opportunity to add ideation categories of comments and other notes for every frame suggested for the user scenarios method in the previous section.

Sketching: Sketching is defined as “the rapid creation of freehand drawings expressing preliminary design ideas, focusing on concepts rather than details” (Hartson & Pyla, 2012, p. 284). Sketching is a powerful tool that “convert ideas into concrete forms that are easier to

understand, discuss, evaluate, and communicate than abstract ideas that are described in words" (Kumar V. , 2013, p. 237). It also helps refining ideas.

In our study, we used this method during the conceptual design phase while visualising concept ideas and concept products. Sketching often done together with brainstorming sessions (Kumar R. , 2011). We decided to use this combination to stimulate more ideas for further exploration.

Expert Evaluation: A design review is a broad term of several usability inspection methods in which one reviewer examines a design to identify usability problems and strengths (Harley, 2018). Different types depend on who is doing the review and the goals behind it. One of the common types is the expert review or expert evaluation. Expert evaluations usually expand on heuristic evaluations by assessing the design for compliance with Jakob Nielsen's usability heuristics but also against other known usability guidelines or other usability-related fields such as cognitive psychology depending on their expertise to help them identify potential issues (Harley, 2018; Hall, 2017). The core components of an expert evaluation are making a list of strengths, problems, severity ratings, recommendations and examples of best practices. In our case, we showed our conceptual design objectives and possible solutions.

In our study, we created a satisfaction scale and asked for the satisfaction level of solutions under the defined objective. Discussions were also made to evaluate components, usability and feasibility. As an analysis, opportunity, barriers and recommendation mapping were made.

Solution Storyboard: Solution storyboard is defined as "constructing narratives that explain how system solutions work" (Kumar V. , 2013). This method is also a specific form of storyboarding. Storyboarding helps to visualize the concept, and solution storyboard can be interpreted as focusing the solutions of conceptual design in an illustrative form. Kumar (2013) lists the benefits of the method as it encourages iterations, facilitates discussion and storytelling and makes abstract ideas concrete. Solution storyboards are used to prepare video prototypes. Thus, in our study, it provided us an opportunity to explain to users more about our conceptual design in an effective way.

3.3.2 Persona and Scenario

This part of the research was iteratively conducted in 3 phases:

Analysis of user profile and problems: Before designing personas and scenarios, different types of users and user characteristics were analysed to develop representative personas and raise awareness of different user demands and problems. Focus group and opportunity map outcomes from Phase Two provided considerable data on this matter.

Persona development: Profiles of three personas were created. We designed the "attracted/interested" profile of a student who is called Ana, the "concerned/not interested" profile of young adult who is called Maria, and finally the "temporary user/traveller" profile of another young adult who is called Daniel. They were intentionally created with different backgrounds, fashion tastes, technology relations, mobility habits and frustrations.

Ana is 21 years old and lives in the city centre. She frequently uses public transport and on-demand transport. She prefers walking compared to biking because she has security issues while biking. She is a student and she goes to university almost every day. She has good technology skills and mostly uses social media, shopping, music and transport applications on her phone. She prefers a casual and sporty style. She is interested and attracted by using a bike and walking; however, she has some minor frustrations. More details about Ana are demonstrated in Figure 33.

Maria is 37 years old, and she lives in the suburbs. She frequently uses a private car, on-demand transport and metro. She has never tried bike-sharing, and she dislikes walking. She is married with one kid and she goes to work every day; plus, she needs to take her kid from school most days. She has medium technology skills and mostly uses a calendar, mail, and navigation applications. She prefers casual and classic style. She is not interested in either target mobility choices and she has plenty of concerns and frustrations. More details about Maria are demonstrated in Figure 34.

Daniel is 30 years old, and he is a visitor who has just come to the city. He frequently uses on-demand transportation. He also prefers biking and walking in his home town. He has concerns about an unfamiliar bike-sharing system. He is a freelancer, and he primarily prefers to work outside. He has good technology skills and mostly uses transportation, navigation, travel advice apps and social media on his phone. He prefers sporty and casual style. He is interested in target mobility behaviours; however, the biggest issue is being a foreigner. More details about Daniel are demonstrated in Figure 35.

Ana, 21, Citizen, lives in city centre

"There are cars everywhere and drivers don't respect bikers. I don't feel safe."
"If the distance is short, bikes are good."

Status: *Single*
Occupation: *Student*
Archetype: *Innocent*
Personality:

Introvert	*Extrovert*
Analytical	*Creative*
Busy	*Time rich*
Messy	*Organized*
Independent	*Team player*

MOBILITY HABITS:
Frequently used modes:
Bus
Metro
Mytaxi

Target behaviours:
Bike-sharing
Walking

FRUSTRATIONS:

GOALS:

TECHNOLOGY:
Internet
Software
Mobile apps
Social media

FREQUENTLY USED APPS:
Instagram, Carris, ShopStyle, Spotify

FASHION:
Trend follower
Shopper

FREQUENTLY PREFERRED CLOTHES:
Ripped jeans, t-shirts, leather jackets

STYLE:
Grunge, Casual, Sporty

She is afraid of traffic and other drivers.
She wants to dress whatever she wants without thinking mobility type.
She likes to sleep and tends to be late.
She likes biking and walking on her leisure time but not every day.

Go to university as soon as possible
Meet friends with stylish clothes
Don't miss the classes and be on time
Listen to music and have enjoyable time while on the way

Figure 33. Persona "Ana"

Maria, 37, Citizen, lives in suburbs

"Who likes to walk anyway?"
"Since I have my driving license, I just take my car."

Status: *Married, 1 kid*
Occupation: *Human resource manager*
Archetype: *Everyman*
Personality:

Introvert — *Extrovert*
Analytical — *Creative*
Busy — *Time rich*
Messy — *Organized*
Independent — *Team player*

MOBILITY HABITS:
Frequently used modes:
Personal car
Uber
Metro

Target behaviours:
Bike-sharing
Walking

FRUSTRATIONS:

GOALS:

TECHNOLOGY:
Internet
Software
Mobile apps
Social media

FREQUENTLY USED APPS:
Google Calendar, Google Maps, Outlook, Twitter

FASHION:
Trend follower
Shopper

FREQUENTLY PREFERRED CLOTHES:
Straight leg chinos, shirts, blouses

STYLE:
Casual, Classic, Chic

She prefers comfort for any other choices. She finds walking unnecessary.
She doesn't want to think about weather or clothes.
She doesn't want to lose time while going to work.
She spends too much time in traffic while on the way back home.
She has difficulty in finding time for kids to have fun.

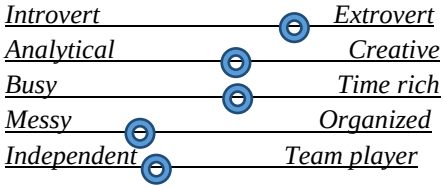
Go to work as soon as possible
Don't go to work sweaty or messy
Spend efficient time with kids
Find time for herself to read and relax

Figure 34. Persona "Maria"

Daniel, 30, Foreigner/visitor

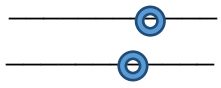
"Which brand is the best? You need to download different apps and discover how it works. Too much work."
"Can I leave the bike wherever I want?"

Status: *Single*
Occupation: *Freelance game designer*
Archetype: *Explorer*
Personality:



MOBILITY HABITS:
Frequently used modes:
Uber
Bike
Walking

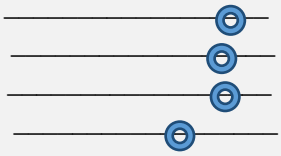
Target behaviours:
Bike-sharing
Walking



FRUSTRATIONS:

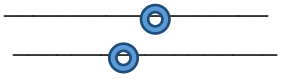
GOALS:

TECHNOLOGY:
Internet
Software
Mobile apps
Social media



FREQUENTLY USED APPS:
Google Maps, Uber, Instagram, Tripadvisor

FASHION:
Trend follower
Shopper



FREQUENTLY USED APPS:
Google Maps, Uber, Instagram, Tripadvisor

STYLE:
Sporty, Casual, Minimalist

Bike-sharing system is different than his country. He gets confused.
He doesn't want to get lost in the city.
He wants to know more about the city and culture but doesn't know where to start.
He doesn't speak the language so he avoids communication and ask for on-demand transport via app.
He doesn't want to search about different bike-sharing brands.
He doesn't know where the bike stations are.

Go to city centre or nice coffee place with Wi-Fi for work
Be online on time at the meeting times
Don't get lost / Discover the city

Figure 35. Persona "Daniel"

Scenario development: Based on the frustrations and goals of created Personas, we made early sketches of the story and worked on the scenario consisting of users' problematic experience (Figure 36). We created one narrative scenario for user problems to take place.

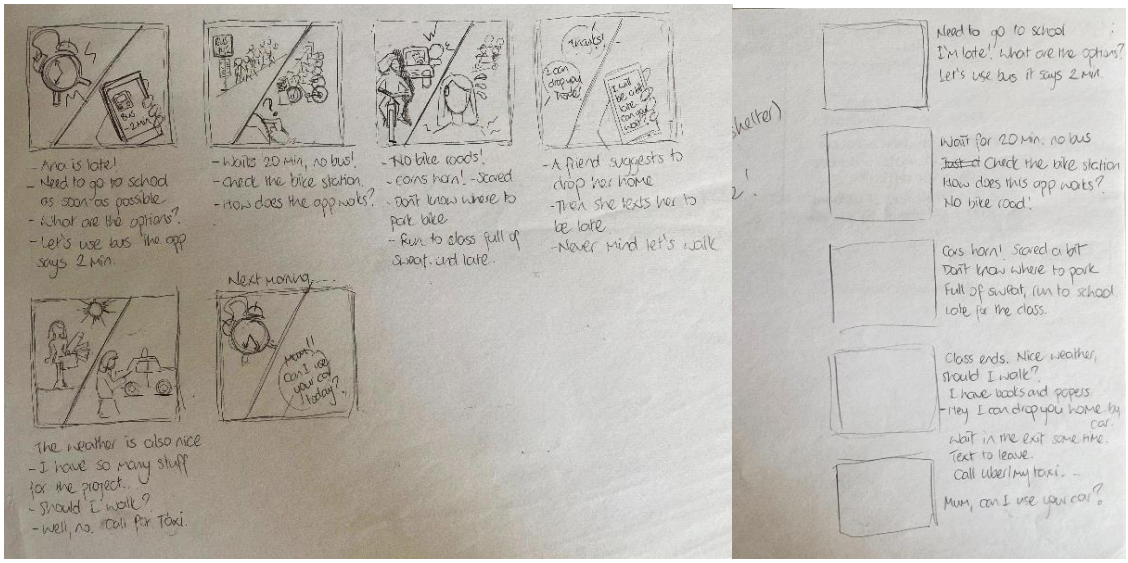


Figure 36. Scenario/storyboard sketches

The problem scenario was structured in the context of the smart city. Ana, Maria and Daniel start their overlapping day in the city. They face some problems related to their personal life and character, and especially targeting sustainable mobility modes. The scenario was built by dividing the inner voices of personas, their actions, and conversations (Table 29).

Table 29. Scenario building

			
Context:	Ana lives in the city centre. She is at home.	Maria lives in suburbs. She is at home.	Daniel lives in different country. He will temporarily live in the city. He is at airport.
Goal:	Need to go to university.	Need to go to work.	Need to find the place which he rented and find a nice coffee house with a proper WIFI to start working.
Inner voice:	I am late. What are the options? Let me use bus, it says 2 min in the app	Car is broken down. Let me use metro to city centre quickly. Then, I'll take bus.	I have a low battery. Let me not use any app, buy transportation card and take metro. House is close to

			metro station.
Action:	Wait for 20 min. No bus arrives.	She takes metro and arrives at city centre. She has just arrived to bus stop.	He waits in the queue for the transportation card. He takes metro, brings his luggage to the house and goes out.
Inner voice:	Should I use bike?	Should I walk? Well, no, I hate it. What about bike?	Ok, now where to go? Oh, cool there's a bike station!
Conversation:	Maria: What happened to buses? Is there any accident? None of them comes… Ana: Could be… Well, I am here longer than half an hour… Daniel: (Hears the conversation between them) I am sorry I was looking for a nice coffee house. I am a foreigner here.		
Action:			He checks tripadvisor for a nice coffee house but gets confused. Places are close to each other. He just needs to find the main street.
Conversation:	Daniel: I saw these on the map, but I am not sure. Maria: Oh, yes. In that street, most of cafes are nice. And it must be 2-3 bus stops further. But apparently something's wrong today. Ana: If you want, you can walk, it is not that far away. Daniel: Yes, could be.		
Inner voice:	I am in a hurry so no time for me to walk.		
Conversation:	Ana: The weather seems nice. I was thinking to use bike. Maria: I've never used it before. Daniel: Well, it's really popular in the city I live. How different could it be? We can give it a try.		
Action:	They walk towards the bike station.		
Inner voice:	Is this the app that I downloaded before?	What if it rains? My clothes would ruin.	Does my transportation card work here?
Conversation:	Ana: Ok it's not that hard, actually. You need to download this app. Maria: So, I need to give my credit card number now? Daniel: Where am I going to park the bike? Can I see the bike stations?		
Inner voice:		When was the last time I biked? I don't really trust this app and I am still losing time here.	This is a bit confusing. Oh, great my phone is dead!
Conversation:	Ana: It seems like there is one station around that street you're looking for. Daniel: It's not really clear actually. Well, and my phone is dead now, so I can't use the app anymore. Ana: I'm sorry… Maria: I think I'll just take taxi. I can't figure this out. Ana: Ok, I am in a hurry so, have a nice day for you two!		
Action:	She starts to use a bike. There is no bike road. Cars horn. She scares a bit.	She takes taxi and goes to work.	He starts to walk towards the direction they showed him until he finds a café.
Inner voice:	Great! I'm full of sweat.		Not a great place but at least there's a WIFI and a socket. I can charge my phone.

Action:	She parks the bike in the closest station. She is late for the class.		He sends the draft of his work to his boss.
	Class ends	Work ends.	Urgent email is sent.
Context:	University	Work	Café
Goal:	Need to go home	Need to go to a shopping mall and then home	Need to explore the city
Inner voice:	I have too much thing to do. I need an inspiration for the recent project.	I am very tired. And I promised to buy this toy to my daughter. I really want to go home as soon as possible and spend time with her.	I have plenty of time. I don't know what to do.
	She calls for a taxi via app on her phone.	She takes taxi to the shopping mall, then takes another taxi to home.	He checks popular places on different applications, checks their location and is able to see only one viewpoint then go to his new house.
NEXT DAY	Takes her mother's car.	Takes her car.	He rents a car for a week.

After the construction of scenario, we illustrated a narrative storyboard (Figure 37) for a more effective representation of problems. In the later phases, we created a video to demonstrate and explain design concepts, problems of users, design solutions and prototypes with the help of these storyboards. We would be presenting each storyboard frame in detail in the Concept Generation and Ideation part to simultaneously show comments, ideation and possible solution notes taken.

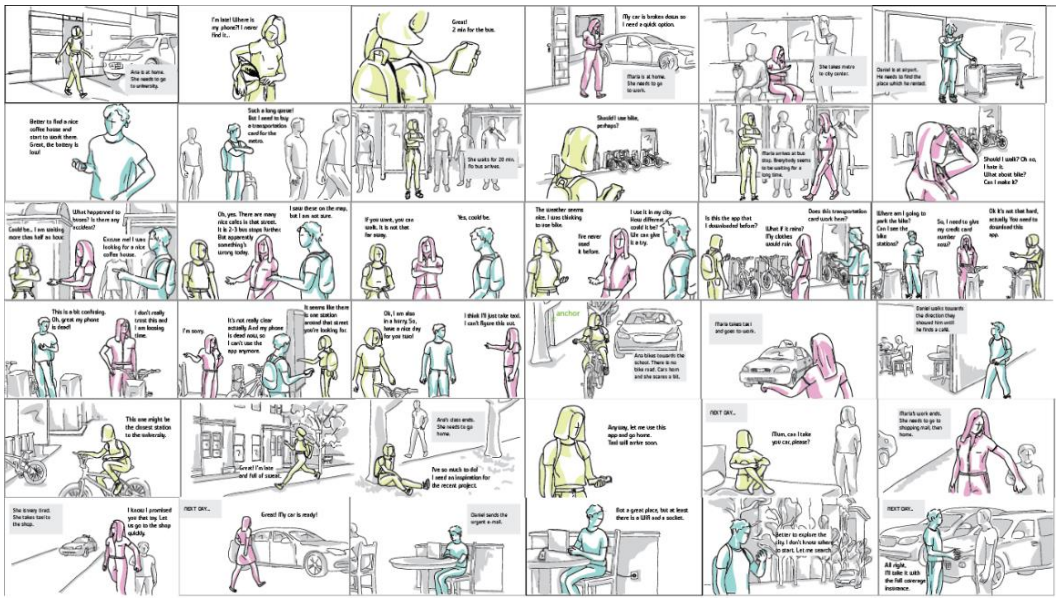


Figure 37. Storyboard frames of Problem Scenario

3.3.3 Concept Generation and Ideation

In this phase, we generated designs by linking concepts, behaviour change strategies, product requirements and user problems together. We used standard techniques to design the concept, including brainstorming, creating maps, diagrams and sketching. The process of this part was also iterative; however, we can mainly divide it into three:

Identification of design strategies and concept requirements: As we reviewed in the literature, we found Design for Behaviour Change Tool strategies (Daae & Boks, 2017) fit best for designing the fashionable wearable concept. Motivating or inducing users to increase the choice of non-motorised sustainable mobility was the main goal of the concept, and we decided to use these strategies as one of the requirements.

Expert feedback from previous phases and literature review suggested that as a designer/researcher we needed to decide on the level of control. On the one hand, forcing users were not found efficient according to experts we interviewed. On the other hand, the literature review supported that both opposite directions have positive and negative outcomes and the decision depends on the situation, product or target behaviour. Figure 38 demonstrates the strategies that we adopted in circles. As it is seen, we tried to be close to the more “user in control” direction.

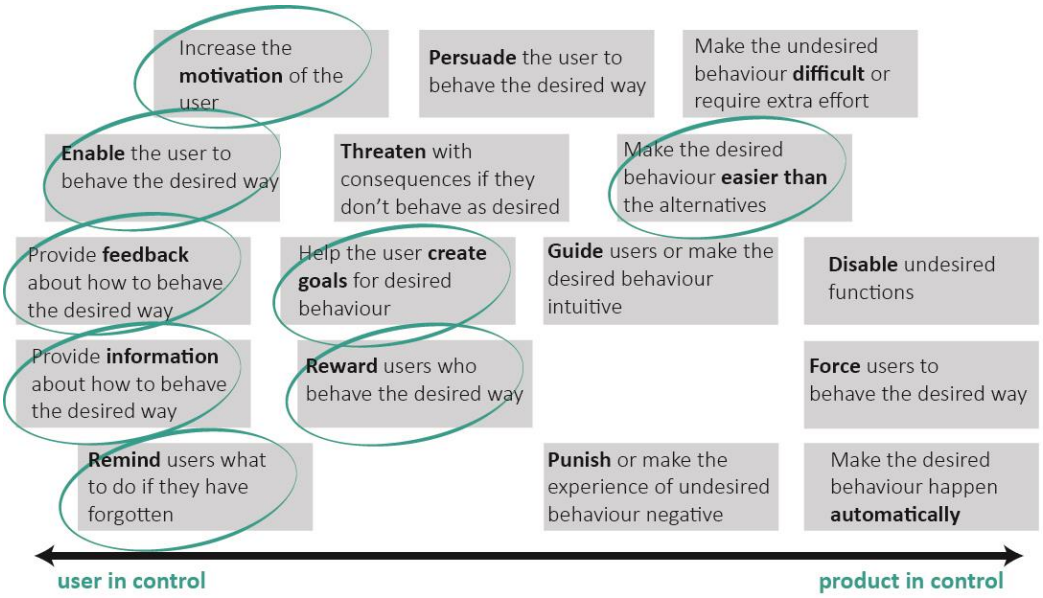


Figure 38. Dimensions of Behaviour Change – Design Principles (adapted from Daae & Boks, 2017) and selected strategies

Another concept requirement was identified as the key factor for constructing fashionable wearables (Seymour, 2009). The concept had a significant smart product in the centre, a fashionable wearable. Therefore, we needed to consider the guideline for the construction of fashionable wearables (Table 30). However, we combined some factors together as they were related to each other.

Table 30. Guidelines for the construction of fashionable wearables (adapted from Seymour, 2009)

Factor	**Considerations**
Ergonomics/wearability	Placement, form language, human movement, proximity, sizing, attachments, weight, accessibility, heat, body shape, comfort, cut of garment, compartments
Perception	Aesthetics, look & feel, design, cultural and psychological functions
Functionality	Usable interaction with the system (inputs & outputs), wearer's control, modular construction for multi-purpose
Technology	Ubiquitous computing, sensor technology, embedded systems design, physical computing
Materials	Interactive or reactive materials/teztiles, e-textile, washing/cleaning, shielding, durability
Energy	Batteries, solar, kinetic, fuel cells
Recycle	Ecological, biodegradable, modular construction for dissemble

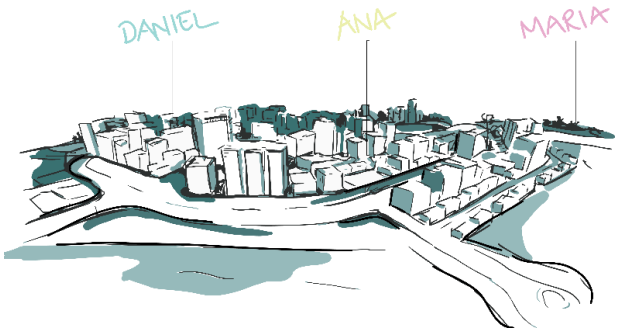
All in all, concept requirements and considerations are demonstrated in the following Table 31.

Table 31. Concept design requirements

Key factors:		**Behaviour Strategies:**	
Body ergonomics	placement, sizing, attachment, weight, body shape, comfort, compartments	**Inform**	provide information about how to behave in a desired way
Perception*	aesthetics, look&feel	**Motivate**	increase motivation
Functionality	usable interaction, modular construction for multi-purpose	**Enable**	enable user to behave the desired way
Technology/Energy	IoT, sensor tech, embedded systems, batteries, solar	**Feedback**	provide feedback how to behave
Materials/Recycle	Textile, electronic textile, washing/cleaning, durability, ecological, biodegradible,..	**Remind**	remind incase of forgetting
		Create Goals	help to create goals
		Reward	reward if they behave in a desired way
		Make it easy*	make it simple, clear

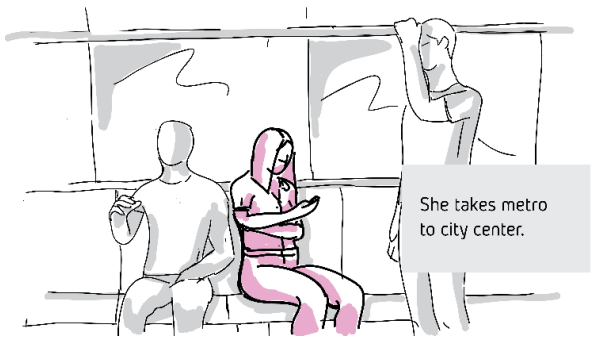
Ideation with problem storyboard: We found it beneficial to generate a broad set of ideas to solve the problems of users and decide which strategies would fit on a particular issue. herefore, we used storyboard frames that illustrate users' problems during the day while on movement around the smart city. We took notes, marked comments, and ideated about concepts, possible features, or strategies to follow. Table 32 demonstrates the concept generation and storyboard frames.

Table 32. Storyboard, comments, ideation

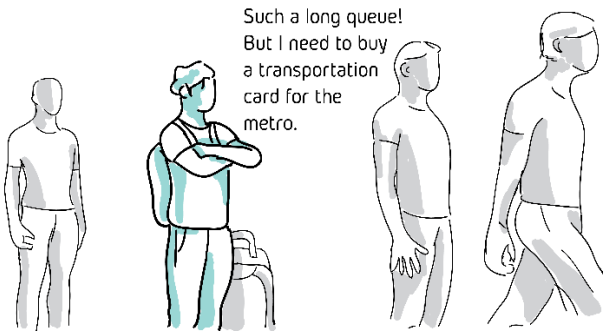
Storyboard Frames ↓	**Comments, Notes**
	Different genders, different fashion tastes, product should address all different tastes and body proportions. Could be an accessory? Patch? Collection of smart clothes? MOTIVATION, PERCEPTION, BODY ERGONOMICS
	
	App, screen something that shows options including bike-sharing, walking, multi-modal, public transport and all types of combination. FEEDBACK, MAKE IT SIMPLE, INFORM
	App that finds location, suggests routes, app that welcomes foreigner, gives feedback and info about the city, transport, weather. FEEDBACK, INFORM

(Welcome to the city, do you want to try new bikes? No one went to this bike station in this neighbourhood. Earn that much point)
CREATE GOALS

Needs alternative for phone? Wearable is easy to find, already worn? FUNCTIONALITY, MOTIVATE, TECHNOLOGY

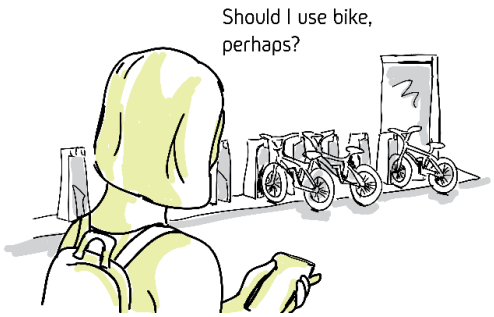


Needs alternative for phone, how to charge the devices? Solar fibres? TECH, FUNCTIONALITY, MATERIALS

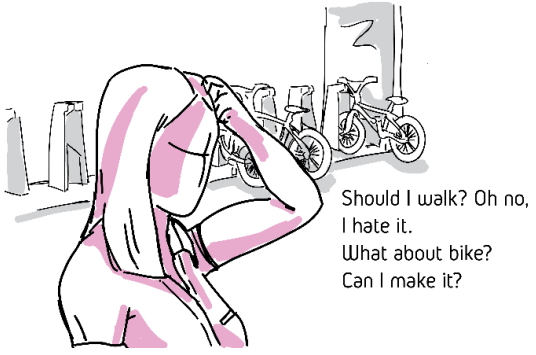


Alternative for transportation cards? NFC tech?
MOTIVATION, MAKE IT EASY, TECH

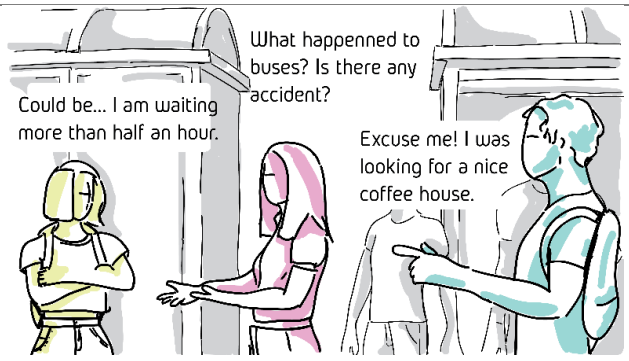
App that shows technical malfunction, road maintenance GUIDE



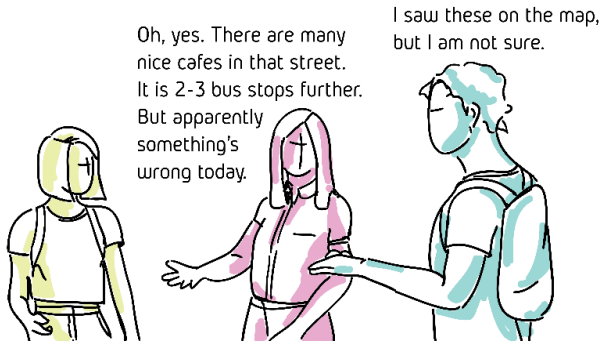
Give suggestions for bike-sharing, give destination details INFORM
holistic app bike-share MAKE IT EASY



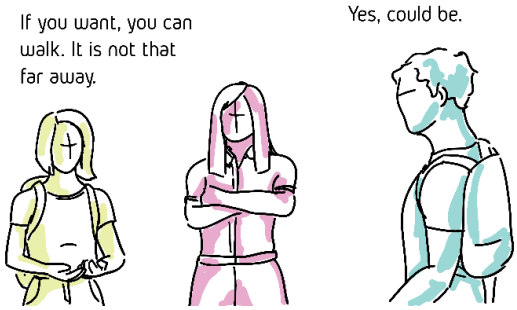
(If you go to that bus stop you will wait half an hour, just go for a walk and then take the bike here in this station. Loose X calories)
REWARD



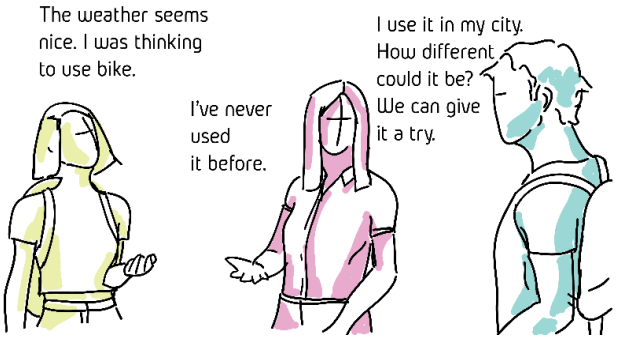
Foreigner advises, INFORM, MOTIVATE holistic app, MAKE IT EASY



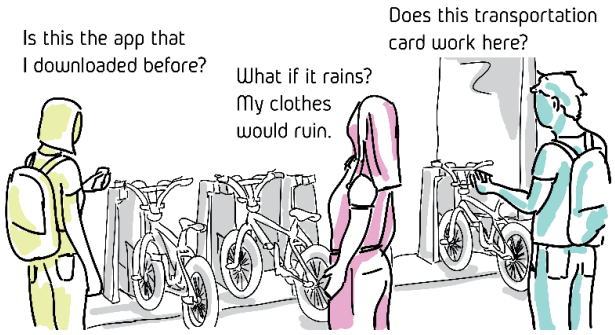
(Just walk straight, oh and did you see this museum? It's not crowded at this time of the day) City database REWARD, CREATE GOALS



(It takes 10 minutes, not more!) GUIDE



Easily scan the QR code with the product, easily launch to the app. MAKE IT EASY

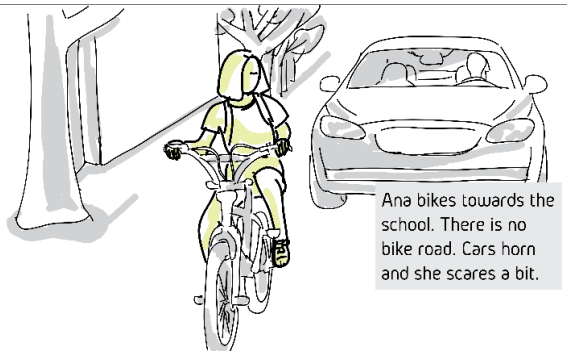


(Weather is sunny today, take a jacket after 20:00) FEEDBACK

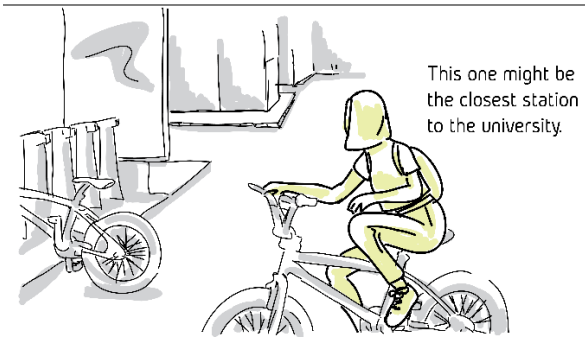
(*Where to go? Nearest stations. Hey take off the bike here so you can enjoy the viewpoint!)* CREATE GOALS, REWARD MOTIVATION

Alternative wearable work as phone. IoT function-connect with the jacket *(Hello jacket, I'm out of battery, will you charge me?)*

(This month you took 9 taxis and used 48kms contributed air pollution %2 in your neighbourhood.) REMIND

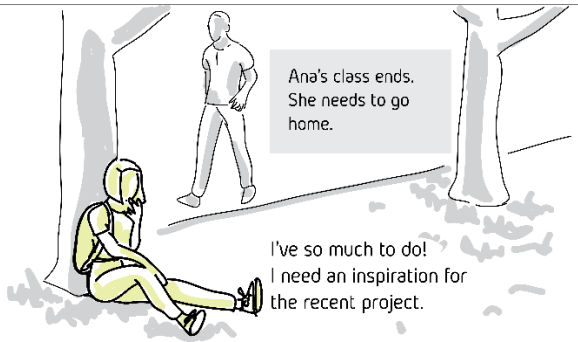


Product that vibrates in certain danger. IoT function: connects to t-shirt and vibrates in the direction where car is coming. INFORM

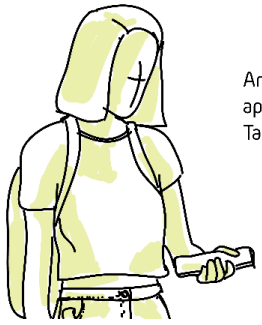


Shows closest station. Quickly end the connection with the product. INFORM, FEEDBACK, MAKE IT EASY

Thermoregulator fabric? MATERIAL

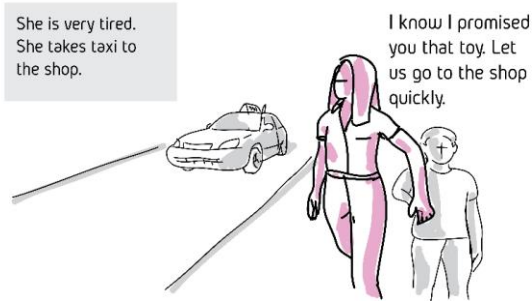


(What do you need?) app shows options, (*Did you see this museum? Exhibition is about conceptual art…) inspire? (Hey, did you see the new exhibition nearby?)* INFORM, MOTIVATE



(You didn't walk much today!) REMIND

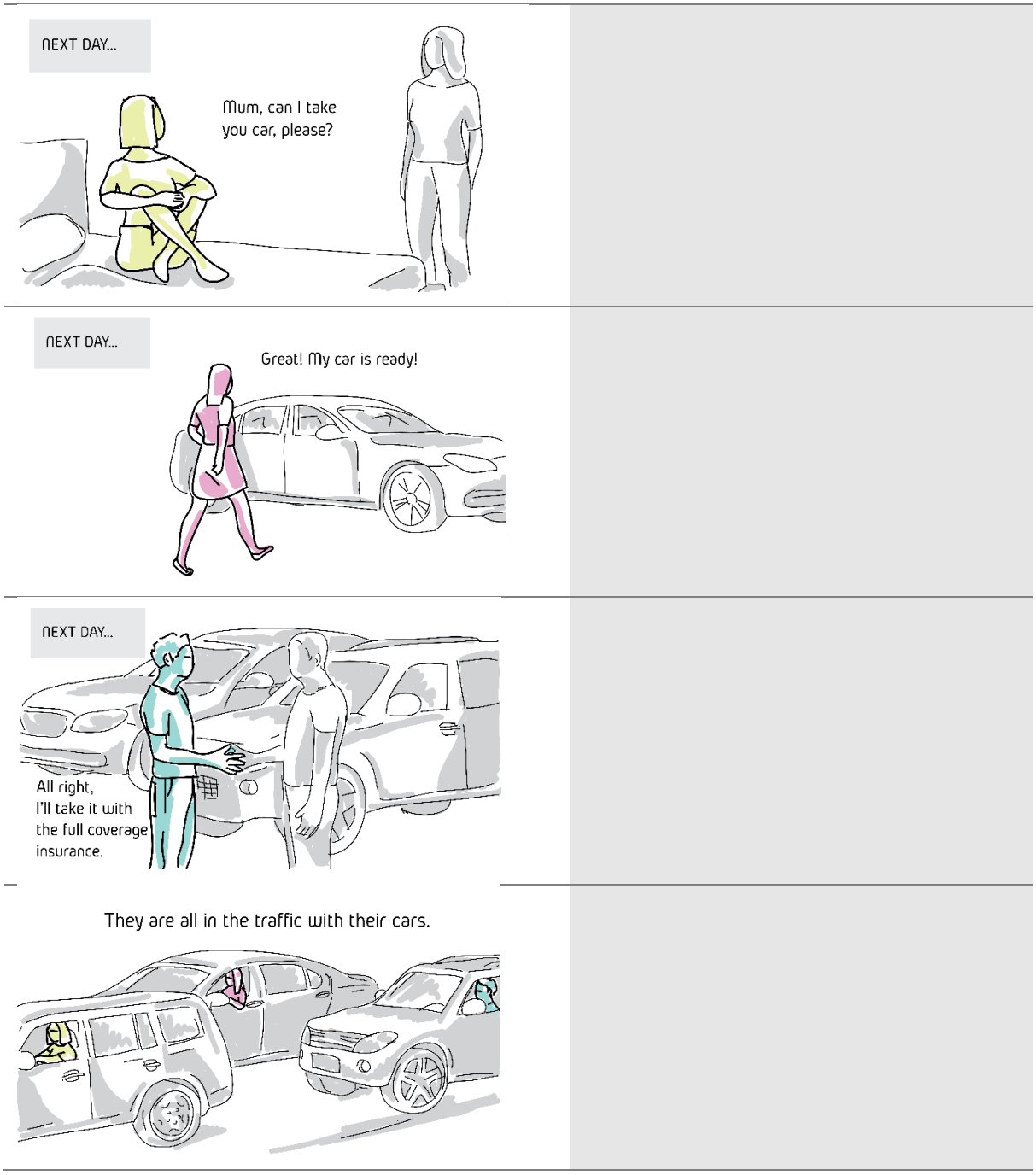
(What do you need?) app shows options MAKE IT EASY



(This is a local store, 90% of mothers are satisfied with the brand. Oh, did you know this playground?) suggestion for kids activity *(This is the famous restaurant, do you need reservation?)* MOTIVATE

Battery charge with clothes? E-textile: Energy harvesting, storage, and generation? TECHNOLOGY

(This is the famous restaurant, do you need reservation?) MOTIVATE



Concept sketching and organising: In this final phase, we used some idea-generating methods such as brainstorming, mind-mapping and sketching (Figure 39 and Figure 40). We sketched ideas on how to influence user behaviour, possible fashionable wearables (arm-wear, body-wear, hand-wear, …), the interface of embedded application screens, the smart environment around the smart product, and much more. Another important part was to match design strategies and considerations with problem topics to organize conceptual design for further evaluation.

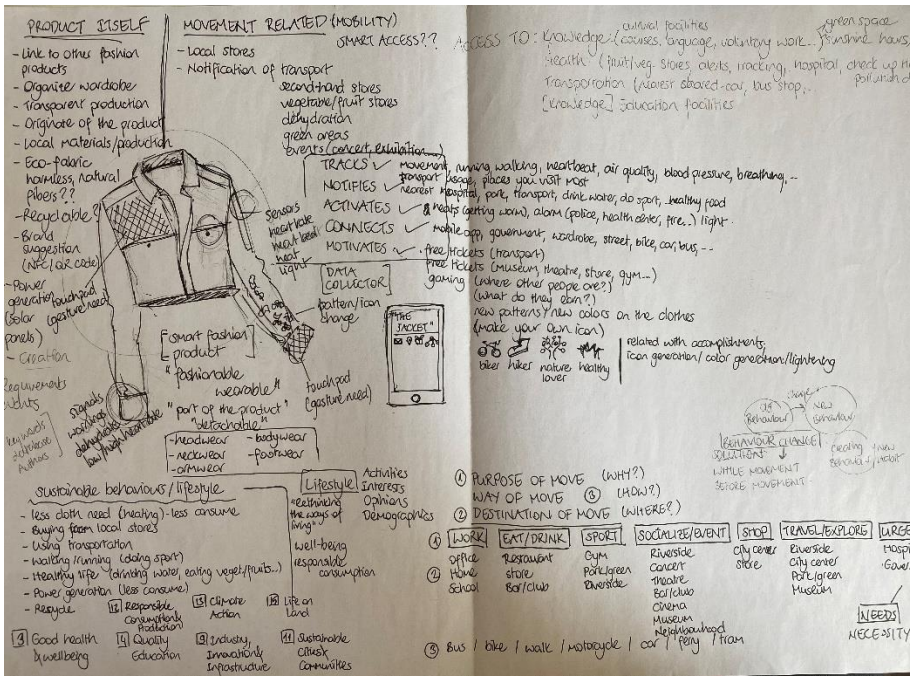


Figure 39. Mind-mapping and sketches

Figure 40. Concept sketching for ideation phase

We matched key factors and behaviour strategies with concept objectives to organise ideas and features of smart concepts during sketching and illustrations. We already had problem topics that we decided to consider in the previous phase. Ideation of possible solutions was linked with concept objectives and problem topics. Table 33 demonstrates that we determined 10 concept objectives for 9 different problem topics. The problem solutions were suggested under these concept objectives. Numbers near objective titles indicate the number of suggestions in a single objective.

Table 33. Concept objectives and problem topics

Concept aimed at (Number of concept solutions)	**Problem topics**
1. Provide options to different genders and body proportions (3) *Key factors: Tech, materials, body ergonomics, perception* *Strategy: Motivate*	Personal excuse
2. Provide options to different fashion tastes (2) *Key factors: Body Ergonomics, Functionality, Materials, perception* *Strategy: Motivate*	Personal excuse
3. Provide guidance and motivation for mobility system (2) *Key factors: Functionality, Technology, Materials* *Strategy: Feedback, motivate, Information*	Digital app, Lack of information, Weather conditions
4. Make aware of the user for the actions taken before (1) *Key factors: Technology, Materials* *Strategy: Remind, Feedback*	Sustainability
5. Create goals in daily life routine (2) Key factors: Functionality, Technology Strategy: Create Goals, Reward, Motivate	Facilities
6. Provide a reward for desirable action (2) *Key factors: Functionality* *Strategy: Reward, Motivate, Create goals*	Facilities
7. Provide an alternative option for mobile phone (1) *Key factors: Body Ergonomics, Technology, Materials* *Strategy: Motivate, Make it simple*	Facilities
8. Provide a solution for battery issues (1) *Key factors: Tech, materials* *Strategy: Motivate, Enable, Make it simple*	Facilities
9. Provide an alternative for transportation cards (1) *Key factors: Tech, materials* *Strategy: Enable, Make it simple*	Demand additional preparation, Confusing
10. Provide security for possible danger (1) *Key factors: Technology, Materials* *Strategy: Feedback*	Security/trust

While we came up with possible solutions in the concept, we categorized them with key factors that needed to be consider (later discussed with experts) and behaviour change strategy

that was selected. Concept details were brainstormed and illustrations were made, as seen in Figure 41.

The next step was to discuss the concept ideas and solutions with experts. These concept ideas would be altered regarding the suggestions and evaluation from experts. Therefore, we will present concept objectives and ideas in the Expert Concept Evaluation part. The finalized version of conceptual design will be explained and illustrated as Solution Storyboards after expert evaluation part.

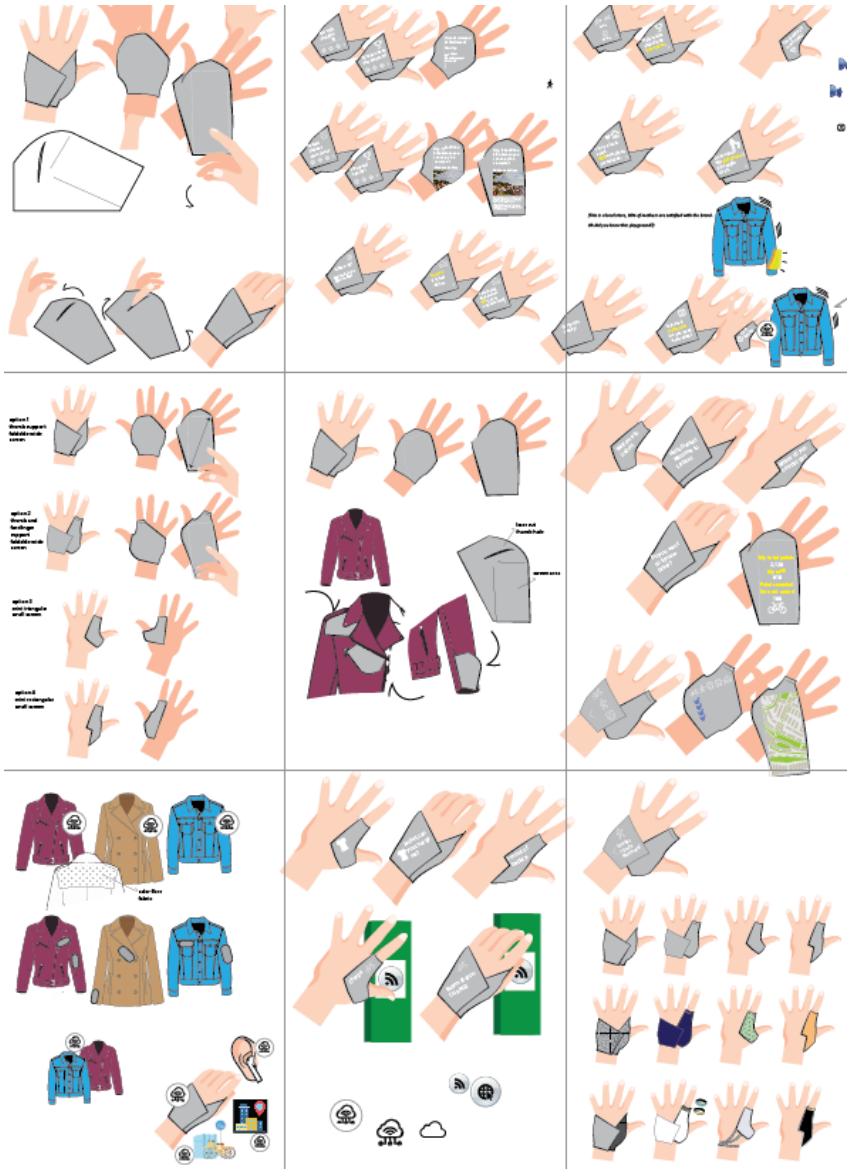


Figure 41. Conceptual design illustration

3.3.4 Expert Concept Evaluation

The concept design was developed by considering previous data obtained from opportunity mapping, persona and scenario creation, and problem storyboard. Opportunity mapping provided us to focus on non-motorised transport modes: Walking and Bike-sharing. Ultimately, target sustainable behaviours were selected as increasing the choice of walking and bike-sharing. Three personas and the problem scenario provided us to interiorize the problems and demands of users that were also gathered from data analyse of focus group sessions. In this part, we needed to evaluate and improve the concept by expert interviews.

The expert concept evaluation part was conducted in 3 phases:

Preparation of interview structure: In the previous parts of the Conceptual Design Phase, concept objectives and concept solutions were organised. We re-designed the objectives and solutions with related illustrations for better presentation. Expert interviews for concept evaluation were prepared in English and Turkish. Interviews were conducted in video form and the questions were semi-structured. Set of 10 concept objectives were predetermined; however, 17 concept solutions were rated in satisfaction Likert-scale (Figure 42). Additionally, we asked open questions depending on the expertise field of experts. We discussed the solutions, ideas, feasibility of the product and concept.

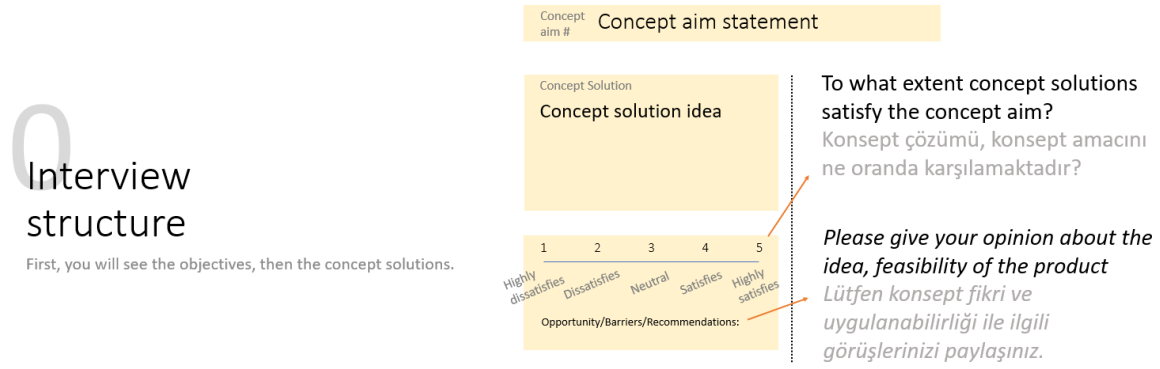


Figure 42. Expert interview for concept evaluation structure guide

We made pilot interviews to refine the interview structure, questions and visual elements. The pilot study was conducted with three experts in the industrial design and textile engineering area. Participants gave their feedback on certain situations that confused them. They also gave suggestions for improving the concept and interview structure. Regarding their feedback and interpretations of their difficulty of understanding the questions and structure, we made some modifications (Table 34).

Table 34. Summary of modifications pilot interviews

Participants	Expert area	Modifications
Pilot 1	Interface design	Eliminated categories: Retyped concept solution ideas Interview structure is redefined
Pilot 2	Textile engineering	Improvement of images, improvement of concept feedback, changed the sketches under categories
Pilot 3	Industrial design	Improvement of concept feedback, added images to clear the concept design process Improvement of 5-point scale, eliminated the feedback of personas, detailed some sketches

Data collection: Interviews were conducted with experts with different backgrounds in design, fashion, textile, software, and engineering areas. Thirteen experts were chosen randomly based on their biographies, experiences, publication topics, courses they lectured, projects they conducted, companies that they work or own. They were contacted via email, face-to-face conversations or phone calls. We were able to arrange the meetings with 10 of them. Each interview lasted approximately one hour and was audio-recorded and transcribed considering concept objectives (Appendix L). We collected quantitative data from Likert-scale choices and qualitative data from open-questions and general discussions.

Analysis of expert evaluation: In the final phase, we both collected qualitative and quantitative data. Concept solutions were evaluated as if they satisfy concept objectives (Appendix M). Quantitative data were analysed in SPSS Statistics software. Quantitative data were analysed using MAX Qualitative Data Analysis (MAXqda) software, tagging statements as opportunities, barriers and recommendations. Due to the determined keywords, similar statements were merged, and different point-of-views were summarized.

3.3.4.1 Analysis and Discussion

The following Table 35 shows the distribution of 10 expert profiles in the form of age, field of expertise, education background and professional activity. The experts were mainly in the different fields of design including interface, product, textile, fashion, interaction and science areas including engineering, computer, and physics. This range of overlapping fields of interests and backgrounds provided us a variety of data.

Table 35. Expert profiles

Experts	Year of Birth	Field of Expertise	Education Background	Professional Activity
E1	1991	Interface Design, Product Design	Industrial Design (PhD)	Teaching assistant, Researcher
E2	1984	Interaction Design	Design and Innovation (PhD)	Assistant Professor, Researcher
E3	1989	Healthcare Textile Design	Textile Engineering (PhD)	Research assistant
E4	1984	Fashion Design, Modular Fashion	Fashion Design (PhD)	Associate Professor, Researcher
E5	1991	Product Design, Vehicle Design	Industrial and Vehicle Design (MS)	Industrial Designer (Aerospace Industry)
E6	1967	Textile Technology and Sustainability	Textile Engineering (PhD)	Assistant Professor, Researcher
E7	1972	Industrial and Space Design	Industrial Design (B)	Designer (CEO of Design/Consultant Company), Lecturer
E8	1987	Software Coding, Computer Engineering	Theoretical and Mathematical Physics (B), Web Design and Coding (B)	Software Test Analyst
E9	1986	Textile Design, Smart Textiles	Fashion and Textile Design (PhD)	Assistant Professor, Researcher
E10	1984	Design Management, Start-up Ecosystem	Industrial Design (MS)	Designer (Co-founder of Industrial Design Consultancy), Lecturer

We conducted ten expert interviews to evaluate and discuss concept ideas. As mentioned in the process, evaluation was performed for each concept solution in two different manners. First, Satisfaction Likert-scale (Highly dissatisfied – Dissatisfied – Neutral – Satisfied - Highly satisfied) was used to identify how satisfied each concept solution was found for its own concept objective. Second, the reasons behind the ranking were discussed in the form of recommendations, barriers behind the idea, opportunities that it might hold.

Table 36 demonstrates concept objectives, asserted concept solutions and the keywords for concept solutions to be used for the following statistic tables. Concept solutions were either in the form of ideas of features of the smart product, system and interface or technological possessions.

Table 36. Concept objectives, solutions and keywords

Concept aimed at	**Concept solutions**	**Concept Solution Keywords**
1. Provide options to different genders and body proportions (3)	A. Key element of the system is a smart half-glove. It is located in hand and wrist area.	A. half-glove
	B. Half glove and other garments of the system has modular pieces. Half glove is detachable to other garments	B. modularity
	C. It has a unisex look, size options and flexible, durable textile.	C. unisex/flexible
2. Provide options to different fashion tastes (2)	A. All garments are part of the system and have contribution. Key element of the system is the half glove which works as a remote controller.	A. system design
	B. It has a unisex look, colour and pattern options. It also has accessory options.	B. customization
3. Provide guidance and motivation for mobility system (2)	A. It gives extra feedback for support and motivation.	A. extra feedback
	B. It gives feedback for garment need.	B. garment need
4. Make aware of the user for the actions taken before	A. It notifies for unsustainable action contribution.	A. unsustainable action
5. Create goals in daily life routine (2)	A. It tracks routines and suggest sustainable options.	A. tracker
	B. It has database for user and other city elements (playgrounds, local stores, etc.)	B. city database
6. Provide reward for desirable action (2)	A. It suggests sustainable mobility using gamification elements. Awards include free tickets, free entries for other city elements.	A. game/award
	B. It suggest gamification elements while on walking status.	B. game/walk
7. Provide alternative option for mobile phone	A. It has phone size option while unfold. It has foldable, touchable screen.	A. phone features
8. Provide solution for battery issues	A. It connects with worn garments and bikes to use solar energy.	A. solar garments
9. Provide alternative for transportation card	A. It has IoT and NFC tech. It interacts with bike-stations.	A. wireless interact
10. Provide security for possible danger	A. It connects to worn garments and sends warning for vibration on the side of the location of possible danger.	A. vibration alert

Table 37 demonstrates concept solutions per mean value, standard deviation and mean value line graph. According to theresults, the standard deviation of items did not appear high except for two topics: 1B (modularity) with a value of 1.29 and 8A (solar garments) with a value of 1.43. Thus, experts were indecisive about these two topics and gave a range of answers on the topic. “1B” was related to the modularity of fashionable wearable and the idea of designing it detachable to other smart clothes in the system such as sleeve, collar or front peace. “8A” was

designing smart clothes in the system with solar fibres so that half-glove could be charged while wearing it. These two topics were also discussed in the Expert's Feedback section that would provide us more clear opinion about this indecision.

There was no item showing under 3 which supports that in overall, concept ideas and solutions were found satisfied enough to reach the considered goal. Highly rated topics were respectively 9A (wireless interact) with a mean value of 4.80, 6A (game/award) with a mean value of 4.70, 2B (customization) with a mean value of 4.60, 3B (garment need) with a mean value of 4.60, and 3A (extra feedback) with a value of 4.50. The highest ranked topic "9A" was related to being alternative for transportation cards and providing a holistic digital card/fashionable wearable with embedded communication technologies.

Topics that have neutral evaluation was 1B (modularity) with a value of 3.10, 10A (vibration alert) with a value of 3.20, and 8A (solar garments) with a value of 3.60. "1B" and "8A" were also showed high standard deviation, which proves that they were poorly evaluated in general; however, some experts ranked high. For the topic "10A" we could say that it was one of the most discussed topics as we will present in the next section. The topic was about vibration alert of wearable when in dangerous situations. Experts suggested different perspectives around the idea.

Table 37. Statistic results for satisfaction of concept solutions

Statistics				**Line graph**
	Concept solution topics	Mean	Std. Deviation	1 2 3 4 5
1	A. half-glove	4.00	0.82	
	B. modularity	**3.10**	*1.29*	
	C. unisex/flexible	4.10	0.74	
2	A. system design	4.40	0.70	
	B. customization	4.60	0.52	
3	A. extra feedback	4.50	1.08	
	B. garment need	4.60	0.52	
4	A. unsustainable action	4.20	0.92	
5	A. tracker	4.40	1.07	
	B. city database	4.10	1.10	
6	A. game/award	4.70	0.48	
	B. game/walk	3.80	1.23	
7	A. phone features	4.10	0.74	
8	A. solar garments	**3.60**	*1.43*	
9	A. wireless interact	4.80	0.42	
10	A. vibration alert	**3.20**	1.23	

1-highly dissatisfied
2-dissatisfied
3-neutral
4-satisfied
5-highly satisfied

3.3.4.2 Expert's Feedback: Opportunities, Barriers and Recommendations

The expert evaluation phase was one of the critical parts of conceptual design. It provided us a variety of perspectives, suggestions. Furthermore, we had supported our concept ideas and avoided making decisions from a single perspective. Therefore, feedback from experts was more important than statistical overviews that we presented in the previous part.

Feedback and discussions will be made under each concept objective. Additionally, initial concept details will be presented.

1. Provide options to different genders and body proportions: There were three solutions discussed in this concept aim. Discussions will be made together in the following.

First, we explained the general concept environment. Our personas had different gender and body proportions. Therefore, designing a piece of smart clothing such as a jacket or shirt was found ineffective for personas. We needed to design a different piece of garments in every weather condition, with different patterns and cuts to fit different sizes and body proportions. In that case, we would be spending a great amount of fabric, textile materials and other consumption products that eventually demand for more than one piece of clothing. This scenario would be unsustainable. Based on these, we decided to design the concept with a main smart product: a half smart-glove (Figure 43). It would be located in the hand and wrist area to avoid gender or body proportion differences.

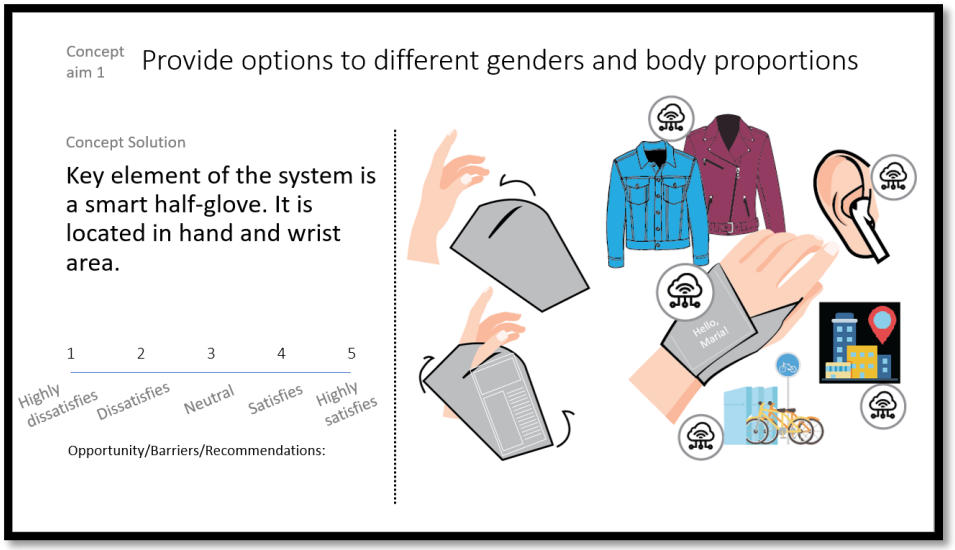


Figure 43. Expert Discussion Card for Concept Aim 1 – Solution A

The second idea in the same objective was proposed as the modularity of the product (Figure 44). This concept had other garments in the system and connected parts with half-glove in default. Therefore, the wearable is detachable to other garments in various points such as collar, neckline or sleeve in need.

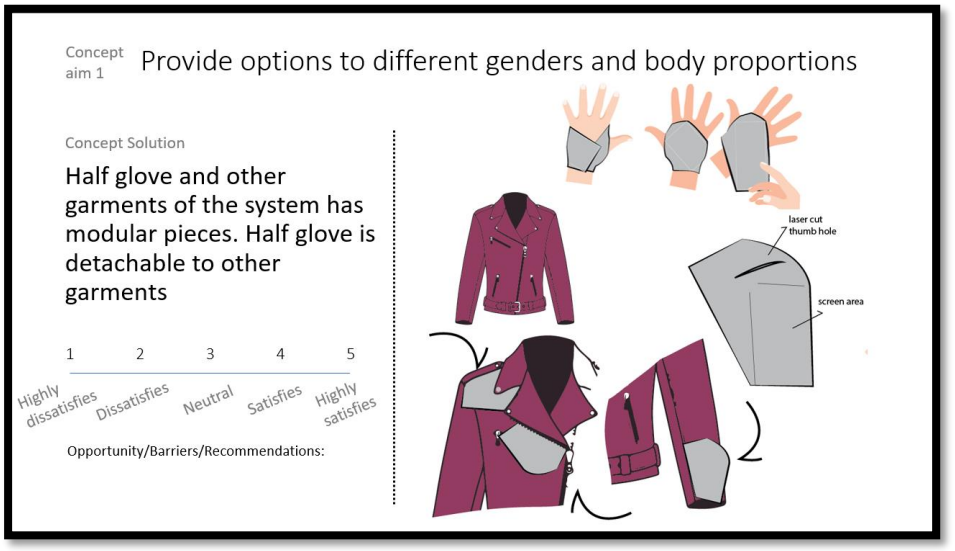


Figure 44. Expert Discussion Card for Concept Aim 1 – Solution B

The third solution was found as producing the wearable with durable and flexible textiles with different size options (Figure 45). The elasticity of the product would avoid the need for different pattern-making and fabric waste. Size options were also asserted as ideas that the fashionable wearable could be formed in either way or selected ways. Four options were proposed as two of them had s wide screen and the others were located in other parts of hands and occupy less space.

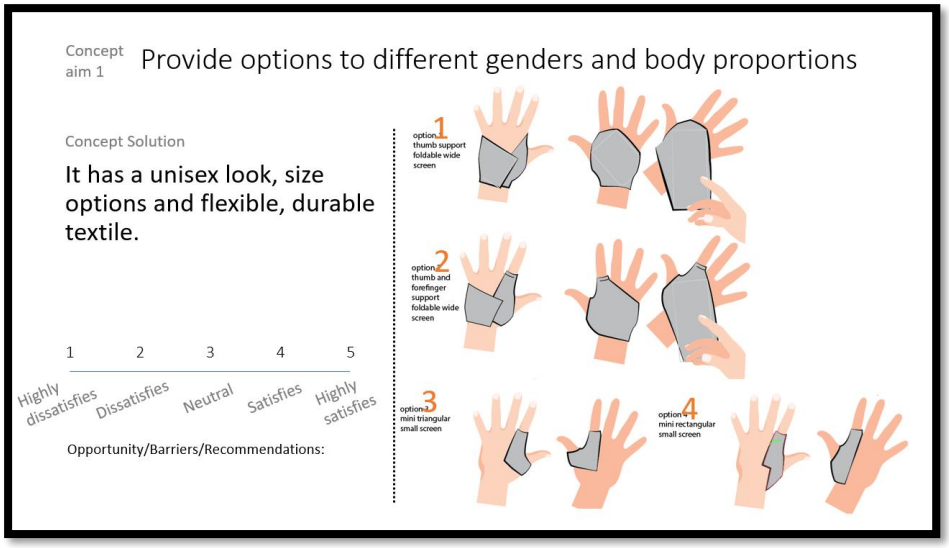


Figure 45. Expert Discussion Card for Concept Aim 1 – Solution C

Feedback: As seen in Table 38, mainly concept ideas were evaluated positively, feedback was in the form of opportunities of solutions and recommendations. The fashionable wearable found practical and portable, was able to fit with any clothes, preferable for users because they are ready for the product after smart watch and wrist/hand area was also found beneficial to avoid body proportion. However, fabric's elasticity might not be enough for different fitting sizes, so recommendations were to consider S-M-L size options.

Modularity feature was only found functional on sleeve for visibility of the screen. Other attachments were not thought functional if it doesn't add additional meaning to put it on other parts of body. It could simply be folded and be put inside pockets. Connection of the wearable with other clothes and the closure was also suggested to use small magnets or other sticky materials except for Velcro, zipper or press studs which demand both hands to use.

For different sizes, large options found more practical for users to continue their habits. On the one hand, experts said that people need larger screens for more information and wrist area is better. Small options have small screens and instead of using them, smart watches might be more preferable. On the other hand, some claimed that screens could be transformed into something beyond our knowledge in the future. We may not need screens anymore. On the same topic in size options, small ones located in the finger was also not found ergonomic.

The other interesting highlight was related to functionality. Experts mostly claimed that functionality was necessary. Therefore, users should test the functionality, ergonomics and comfort of the product. Also, it was claimed that people were not rational to think about

comfort. The wearable could be symbol for identity and have semantic meaning that users' priority would be not the comfort anymore.

All in all, decisions were taken in the following issues:

- Add three different size options S-M-L
- Add options for right-handed and left-handed people
- Eliminate small options
- New design need for finger support for 1st option
- Use sustainable, anti-bacterial, washable fabric
- Use small magnets for closure of glove
- Modularity with other garments will be used only on sleeve

Table 38. Feedback for concept objective 1

Concept Objective 1 – Concept Solution A – Feedback	
Opportunity	1. Adaptable to different size options. 2. Wrist/hand area is a good idea to avoid body proportion. 3. Users are ready for this product after smart watches. 4. Convenient for city life activities (walking, biking) 5. It can fit with any kind of clothes. 6. Portable and practical.
Barrier	1. Hand sizes are different and even though the material is elastic, it might not be enough. 2. Product might be disturbing and restrict the movement. 3. It might bring hygiene issues because we use our hands for many activities. 4. Finger support might not be enough; it may curl or slip. 5. It might damage easily while you hold handlebar of bicycle because of the pressure.
Recommendation	1. Decide the data you want to collect, then decide the location of the product. 2. Consider 3 different fitting options with Velcro or press studs. 3. Consider S-M-L size options. 3. Consider sustainable fabric and accessories. 4. Consider soft padding parts inside or additional transparent layer like a case for protection. 5. Consider right-handed users, screen could be in both side. 6. Consider one more support in the last finger or others. 7. Could be a bracelet with wider straps, smart watch or smart ring.
Concept Objective 1 – Concept Solution B - Feedback	
Opportunity	1. Functional to attach on sleeve for visibility of screen. 2. If users don't want to wear the product on their hand, they can easily take it off and patch on their body quickly. 3. Users might not want to wear it all the time. 4. Phone screens are getting bigger and hard to carry. 5. We still need screens for the near future.
Barrier	1. Users might not want to attach it on a noticeable body part. 2. It is foldable and is able to be reshaped easily. Users can fold and put it inside of their pocket or bag. It is not necessary.

	3. Velcro, zipper and press studs need both hands to use. Velcro could get dirty. 4. Not functional, doesn't have additional meaning to put it on your body. Except sleeve part. 5. This concept is so hardware oriented and belongs to today.
Recommendation	1. Could be attachable inside of the clothes. 2. Decide how to attach this on clothing. Could be small magnets or other sticky materials. Magnets are more practical. (Check Neodymium magnets) 3. Exclude the valuable components of the glove like processor, micro-controller or screen driver and keep it in safer place. You can transfer data to glove by wireless. In that case, you can use these little magnets or other elements that you consider harmful. 4. This hardware (wearable) must be thought as embedded to our body but not an external product around us.
Concept Objective 1 – Concept Solution C - Feedback	
Opportunity	1. It is better for a wearable to be in wrist area and has larger screen for more information. 2. Large options (1-2) are more practical for users to continue their habits. 3. In your 2nd option, you have thumb support, point finger support and the closure part support. Therefore, it is sufficient. It won't be off your hand; it won't widen and no other object could be stuck between glove and your hand. 4. It is possible to create a fabric that functions as a flexible screen. They have already created fabrics that function as touchpad on sleeve. It is an opportunity and you can think different shapes of screens. 5. If your product offers a better experience, these options are meaningful. 6. People are not rational to think about the comfort. If we are, we won't be consuming half of the products today. This product can be a symbol for identity. This may have a semantic meaning.
Barrier	1. Small options (3-4) can be discomfortable because of the location. They might easily slip, or non-slip fabrics/layers may not work on joint. 2. Small options have small screens. Instead of them, users can prefer smart watches or bracelets. 3. 2D sketches might not provide the same experience on hand. In regular position of hand, some part of the screen might not be seen. 4. 1st option might have ergonomic issues. It doesn't have enough support. It might also slip or curl.
Recommendation	1. Think about the interaction with it while on call. 2. Analyse biker gloves. They have multiple parts and fabrics such as soft pads for friction, terry towel for wiping your forehead. Think about functionality. 3. If any object is located in the most dynamic place, it must have a support from 3 points at least. 4. Consider materials such as in watches that cover your wrist immediately when you wear without using any connection material. 5. Consider second skin, e-skin technology to avoid slipping issues on hand. 6. You don't need to define the object as a glove with a screen for the future. It can be anything beyond our knowledge. 7. You should relate the sizes and locations on hand to UX.

2. Provide options to different fashion tastes: Since we had three personas with different fashion tastes, we needed to think about it. There were two characteristics of the conceptual design asserted as solutions discussed in this concept aim. As mentioned in previous concept

aim, this concept design had a smart environment that made it a system. Designing a smart half-glove that works as a remote controller of the system provides other garments to be included in the system (Figure 46). This means that any kind of clothing belonging to any fashion taste also smartly designed in default. Users are not restricted to a single accessory.

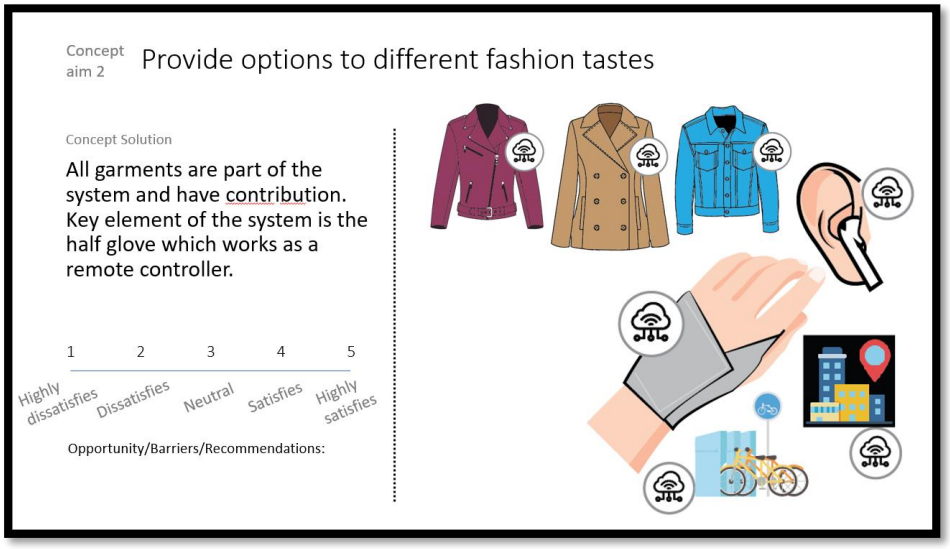


Figure 46. Expert Discussion Card for Concept Aim 2 – Solution A

Another idea was related to customization (Figure 47). These features were designed for a debate. We also had doubts about the technology. Different colour or pattern options were designed for users. However, it was not certain whether these wearables were found in different colour options or wearable is designed in one colour and pattern, and users can change it during usage. Accessory options were added as rings and other wristband-like chain materials just for appearance without any function.

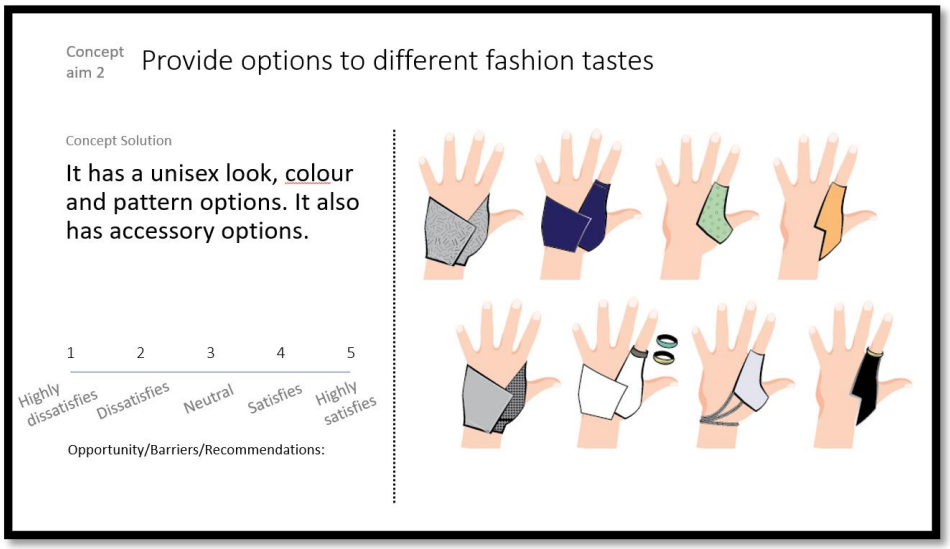


Figure 47. Expert Discussion Card for Concept Aim 2 – Solution B

Feedback: For this concept aim solutions, experts gave mostly recommendations for enhancing the concept. They barely had statements to be considered as barriers of design (Table 39). Experts claimed that clothing is expected to be smart in the future, and they need to share their data; thus, the glove is a good idea to be their screen. Plus, they were found usable for every weather condition unlike jackets. The only barriers were found or physical looks. The elastic bandage looking might not be found aesthetic for all users, and the fabric was needed to be chosen carefully in order not to look cheap.

Customization was found important as people try to customize everything, including medical masks. However, a unisex look is a minimalist manner which was found as a proper strategy. Colour changing was claimed to be done by screen background via an interface. Customizable e-inks that provides display animation were suggested. Additionally, colour-changing fabrics and thermochromic inks were mentioned, these materials change colour related to weather conditions, and this technology was told to get better in the future. There were also other opinions such as preferring the colours that the majority might accept with a sense of more "technology look" or skin colour that makes it invisible. As a last recommendation for additional accessory customization was found meaningful if they had additional functions or sensors. However, personalization is an important strategy, and those additional accessories might differentiate the user from society being just a simple aesthetic object.

All in all, decisions were taken in the following issues:

- Consider all parts of the glove as a screen that change colours and pattern
- Work on additional modular accessories for a more fashionable look

Table 39. Feedback for concept objective 2

Concept Objective 2 – Concept Solution A - Feedback	
Opportunity	1. This technology is not picky in terms of a specific style or garment type. Users might feel free to use any kinds of clothes that fit their style. 2. Clothing is expected to be smart in the future and they need to share their data and gloves is a good idea to be their screen. 3. Clothes bring different fashion tastes. Smart jackets, tights and other products have already been produced but a few people preferred so far. 4. You can use it in every weather condition.
Barrier	1. It looks like an elastic bandage and might not be found aesthetic for all users.
Recommendation	1. Product can be sold with a kit including all clothing options or just connection materials or external sensors (or solar parts). 2. Think about the quality of the fabric.
Concept Objective 2 – Concept Solution B - Feedback	
Opportunity	1. Customization is important for users. We even tried to customize masks in pandemic.

	2. You can customize the screen background via interface. The screen must have a cool-down screen. You can change the colour of screen-lock for customization. They designed sneakers (Shiftwear) that have customizable e-ink. The display was animated and this was years ago. 3. Colour changing fabric is not that difficult. There are materials that change colour related to weather conditions or if you heat intentionally. In the future it will get better for sure. 4. Unisex look is a minimalist manner which is a proper strategy. 5. Secondary accessories to personalize the product is a logical strategy that was performed by best technology companies.
Barrier	1. It is hard to perceive technology and recommend something. We might be using products that we cannot imagine today. 2. Quality of fabric and texture is important and it shouldn't look cheap.
Recommendation	1. Consider to separate smart/screen part of the glove and give options for the rest of the part like watch straps. 2. Go with the colours that might be accepted by majority and invisible. Prefer more basic colours such as white, grey or black with more tech look. 3. Users may prefer it as skin colour. Every human colour is different so this product can copy that skin colour and change accordingly. 4. E-ink is a flexible display that looks like paper, and you can change the colour. User can buy one option, change the colour as they wish. They can even draw their own patterns. 5. Could be made of leather, scuba-type, or denim. 6. Consider thermochromic ink for some part of your patterns and the other part with pigment ink. You can provide pattern colour change due to temperature. 7. Consider weaving or knitting the fabric with shape-memory alloys. Fabric changes into the defined shape in determined temperature from its normal state. You can take this glove off and give a certain heat to make it smaller so that you can keep it in a small area. Or depending on temperature again, you can grow a finger part. 8. The secondary accessory can have a meaning not only having an additional function or sensors, but also just a simple aesthetic object that differentiate user from society.

3. Provide guidance and motivation for mobility system: For this concept aim, two characteristic of concept was asserted as solutions discussed. One of them was giving extra feedback for support and motivation (Figure 48). For example, if a user was indecisive about taking decision of walking or quitting walking, the wearable might display "It takes 10 minutes, not more!".

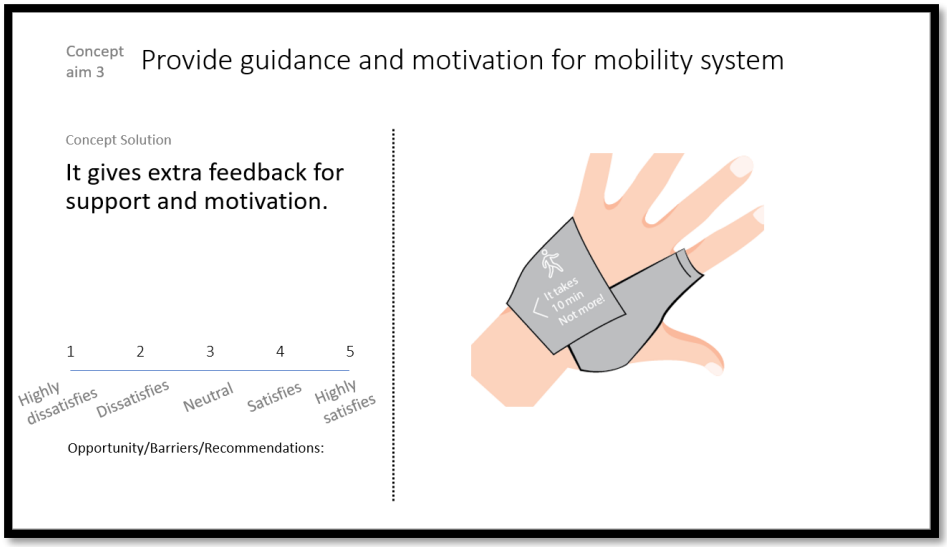


Figure 48. Expert Discussion Card for Concept Aim 3 – Solution A

Another was giving information about weather and gave suggestions for clothing (Figure 49). Examples might be given as wearable warns the user because it knows the weather will worsen after a specific hour. It simply suggests users wear a raincoat or take a coat with them in case of getting cold.

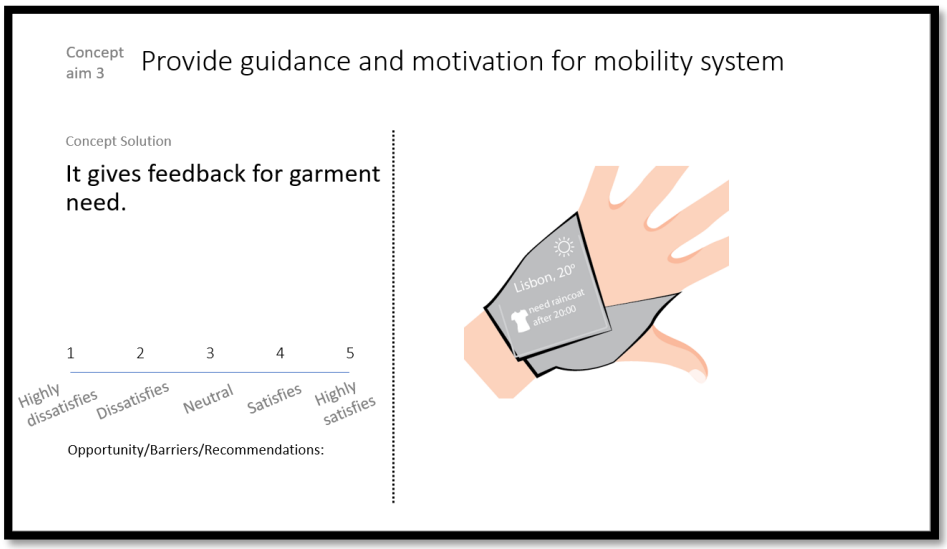


Figure 49. Expert Discussion Card for Concept Aim 3 – Solution B

Feedback: There was not that much discussion made on these topics, according to others (Table 40). Experts claimed that these kinds of feedback are pleasant and motivate users; it was done and successful before. Therefore, it could be still valuable depending how you do it and user experience feedback. It was suggested to work on details, feedback timing, text details and tone.

There was an interesting highlight from one expert related to today's generation perspective, that might be useful for future foresight. It is claimed that today's generation's motivation is related to visibility. They do not want to be a person who is healthy or sportive but to be known as a healthy or sportive person. "Your individuality is for being consumed by collective today." Therefore, it might be better that these feedback have a collective meaning.

Decisions were taken in the following issues:

- Check interfaces for better user experience
- Give suggestions not only for clothing but also other accessories such as an umbrella
- Work on the language of feedback

Table 40. Feedback for concept objective 3

Concept Objective 3 – Concept Solution A - Feedback	
Opportunity	1. These kinds of feedback are pleasant and gives motivation to users. 2. UX side is important here. Doing something that was done and successful before, still valuable depending on how you do it. 3. Users don't have to check or control by themselves. It stimulates user via vibration, colour change or voice for the feedback, it is logical.
Barrier	1. A machine that fakes as human might bother users. 2. Mobile phone does the same thing. Why should user have this instead of mobile phone? 3. There are hundreds of products and applications that give these kinds of feedback. This idea has already consumed and old-fashioned.
Recommendation	1. Work on details, feedback timing, showing target point. 2. Consider voice notification or vibration for paying attention. 3. Today's generation's motivation is related with visibility. Not to be a person who is healthy or sportive but to be known as a healthy or sportive person. These feedback might not even work today, so it must have a collective meaning. Your individuality is for being consumed by collective today.
Concept Objective 3 – Concept Solution B - Feedback	
Opportunity	1. It works for societies that need motivation for biking. 2. Some operating systems give you information about weather every morning. This means that people need to be informed about this. Yours gives information during the day which is better. 3. If this information is given without user's intention to check weather, it is beneficial. User can pay attention and consider to change the outfit.
Barrier	1. Depends on culture. Might be too ordinary or not meaningful for the developed societies who use bicycles every day.
Recommendation	1. Work on details. It can give extra information or more detailed texts. 2. It might suggest accessories like umbrella not only clothes. 3. Work on interface. Icon doesn't seem right.

4. Make aware of the user for the actions taken before: Only one solution scenario that was suggested as solution in this concept aim. Making aware of users by giving feedback from

earlier unsustainable actions (Figure 50). This could be a simple warning such as "You didn't walk much today/this week/month". Since the wearable has a database of your mobility decisions and tracks you, it can also give information of your monthly decisions: how many times you preferred taxi, on-demand transportation or personal car; how many kilometres you used them and how these actions can have negative impacts on the planet.

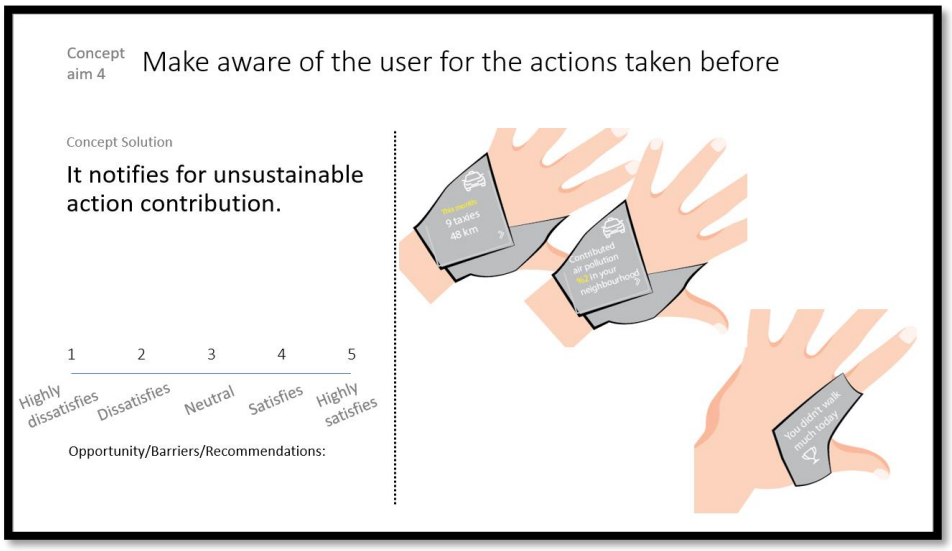


Figure 50. Expert Discussion Card for Concept Aim 4 – Solution A

Feedback: Experts mostly gave recommendations and mentioned opportunities of the concept (Table 41). However, experts had a conflict on the type of data and the language that was being shared. One side claimed that it gives information in a negative way, and sometimes it is better to remind that they are not good enough. Plus, it might have collective meaning that users could compete with each other to be more acceptable in society. The other side supported that the language should be changed in a more positive way because this might be annoying for people, and they can quickly turn this off.

Decisions were taken in the following issues:

- Give the data for unsustainable actions but try to change the tone of the language.

Table 41. Feedback for concept objective 4

Concept Objective 4 – Concept Solution A - Feedback

Opportunity	1. It gives information not in a positive way but in a negative way. Sometimes it is better to give information and remind that they are not good enough. 2. This data can have a collective meaning. It has a potential to make user more consumable. Based on this information, user might be more acceptable in society. If it is seen from the perspective of political correctness, this is important. 3. Any kinds of data can be analysed in the future considering that lots of information will be

	on cloud. 4. Normally, users might not want to be informed about these issues. But when they see them, they try to change their habits. These notifications have power to motivate people.
Barrier	1. It might be annoying and demotivate users because of reminding negative issues. It somehow blames users for their actions. They can turn this off. 2. It depends on user's perspective.
Recommendation	1. Better to change the language. Could be more positive. 2. Better to give positive feedback. Such as "Well done. You didn't use your car today". 3. Could warn you for other sustainable behaviours except from mobility. 4. Could be more detailed information. Sometimes, you have to choose unsustainable mobility because of the conditions. It should not warn users for everything but only unnecessary choices. 5. Give feedback indirectly. Inform about others around the user what they have done that month. For sure, the user has done the same so it is not only their fault but the user's also.

5. Create goals in daily life routine: Two solutions were discussed in this concept aim. The first one was related to displaying sustainable mobility options and combinations of mobility modes, including biking, bike-sharing (nearest bike-share stations), walking and other options (Figure 51). Additionally, while you are out of your house, it suggests you walk to the bike station and lose this much calory. It creates a goal to walk to that station even though that was not your aim for that day.

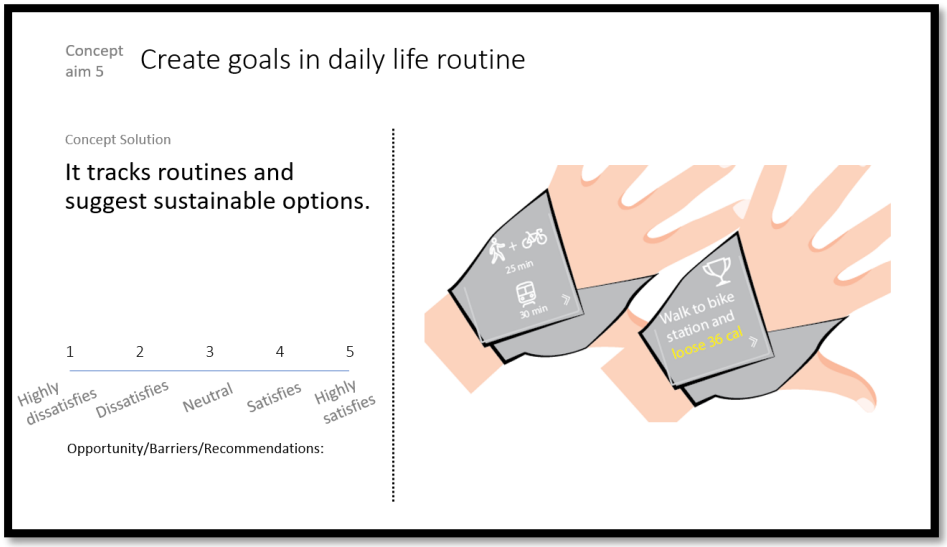


Figure 51. Expert Discussion Card for Concept Aim 5 – Solution A

The other feature of the system is to have a database of the city and user (Figure 52). This means that it knows user preferences and interests; therefore, it can make meaningful suggestions. The city database includes local stores, restaurants, playgrounds, green areas, and others. For example, it can suggest you go to the very close playground. However, you were

not aware of it so far. In that case, you can spend time with your kid in a new pleasant location that was reviewed and ranked by other users.

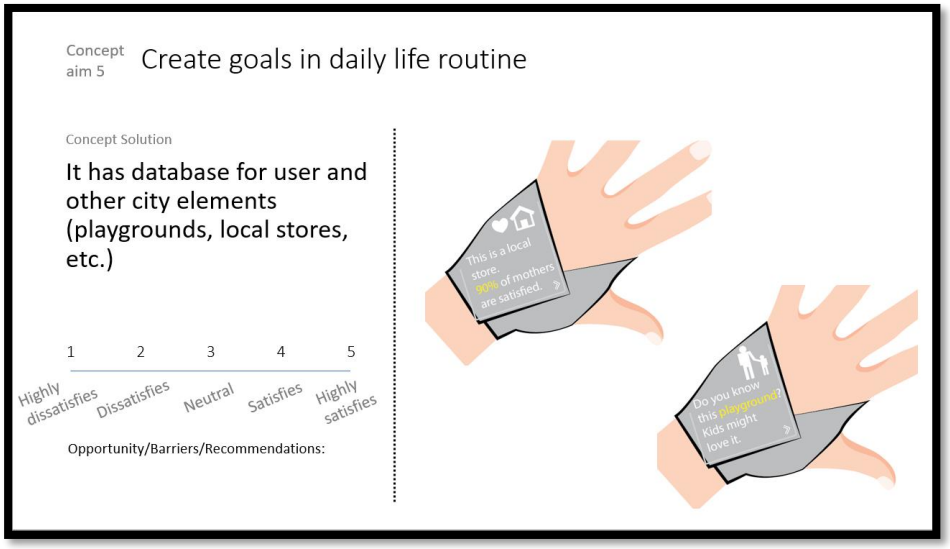


Figure 52. Expert Discussion Card for Concept Aim 5 – Solution B

Feedback: Experts gave suggestions for the topics, and mainly, more barriers were defined for the second topic (Table 42). It was generally found that giving combinations and making sustainable mobility options more visible in the interface was claimed as opportunities for the concept. However, the content might be enriched. Suggestions for the rated places were also found beneficial because user comments were claimed to have higher importance and validity. Plus, this might be useful for tourists but annoying for the citizen.

Decisions were taken in the following issues:

- Enrich notification content and provide filtering

Table 42. Feedback for concept objective 5

Concept Objective 5 – Concept Solution A - Feedback

Opportunity	1. Current apps only give combination for walk and bus for instance. Not bike. 2. If walking and biking options were more visible in the interface, it would be clearer and more preferable for users. 3. It is good to know your reward in advance. To see how much calories you can loose is actually better.
Barrier	1. Users can have this information from anywhere. The presentation style might change, or it can add a meaning to my presence in society. This one is a bit vague.
Recommendation	1. Should give specifically sustainable suggestions not any suggestion. 2. Advise for loosing that calory and also deserve to drink one glass of beer or one bar of chocolate. 3. Enrich the notification content. Just a simple “go for a walk” is not enough. But if it says

	you can burn the calories that you gain from the hamburger you ate last night, is great. 4. Need to better define gamification concept.

Concept Objective 5 – Concept Solution B - Feedback

Opportunity	1. After pandemic and online shopping, user comments get higher importance. It is really important to see other's comments and suggestions. We mostly depend on user comment when we consider to buy a simple product now. It is old but still valid. 2. This feature is better for tourists when user has no idea about the environment.
Barrier	2. Could be too much guidance and information. So, users might be disturbed. 3. Imagine that you are in the city centre and everywhere is filled with restaurants and market, you would get tired of this. 4. This is tracking and it knows where you are. So, it is like sharing your personal data. This is part of our life now, and I am not sure about the future. 5. This system should not promote user to consume more. In that case, could be unsustainable in other way.
Recommendation	1. It can make the filtration according to user's interest and gives you better and less information. 2. Could be sustainable goals. Not any goal. For the restaurants you can add vegan options. So, the suggestion should only be related to sustainable options. 3. Should be optional. Users can limit or get the information when they want. 4. Give users different data for the places they have experienced before like discounts.

6. Provide a reward for desirable action: Two possible scenarios were asserted as solutions in this concept objective. Both of them was related to gamification. The first one was to have a gamification system that provides free tickets for museums, transportations, free entries and trials for other city elements (Figure 53). The system basically suggests you use sustainable mobility modes, and in return, it allows you to earn points. It also ranks you and gives information about the rank of your friends or neighbours.

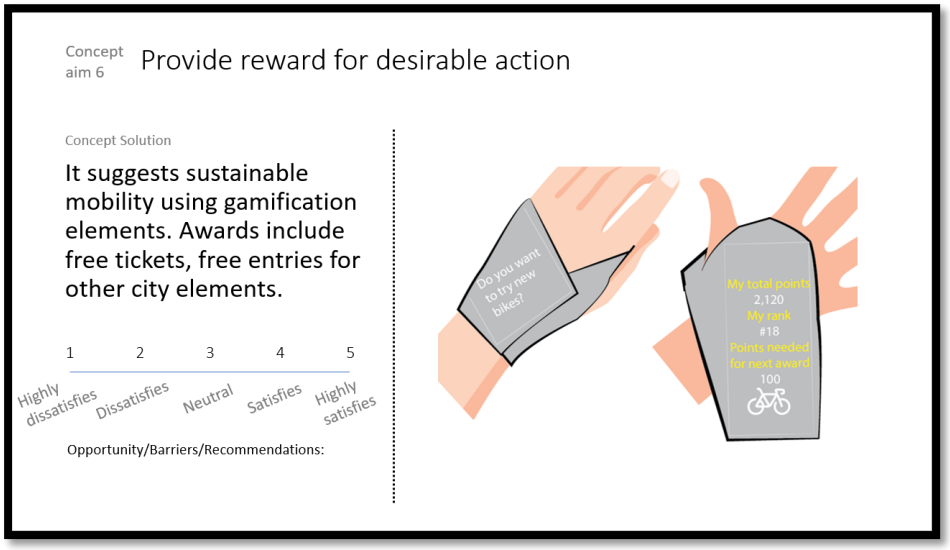


Figure 53. Expert Discussion Card for Concept Aim 6 – Solution A

Another part of the gamification system suggests you go to cultural or iconic places such as museums, view points, or restaurants while you are walking (Figure 54). When you are out of your house and walking without any specific destination, it creates goals and makes you earn points from those.

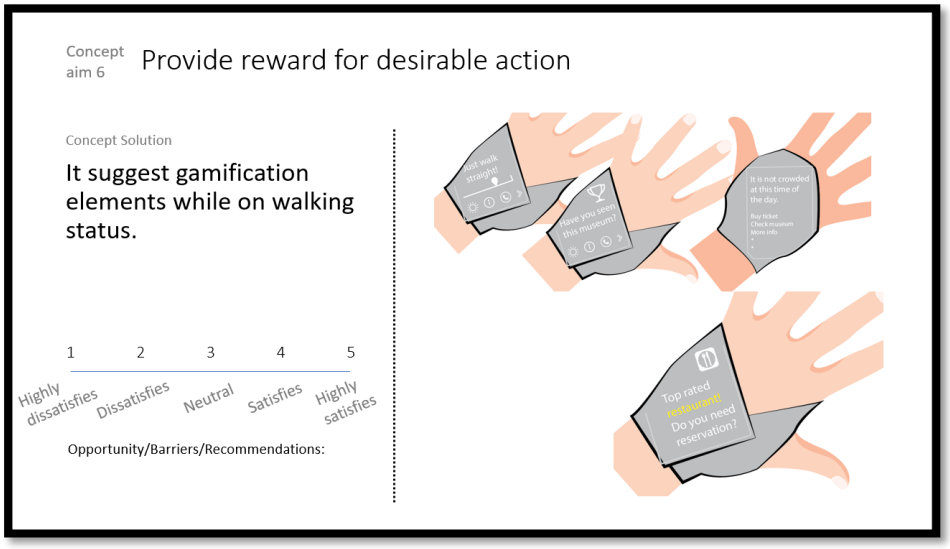


Figure 54. Expert Discussion Card for Concept Aim 6 – Solution B

Feedback: Expert opinions were slightly decreased in this concept objective; however, they found opportunities and drawbacks (Table 43). Gamification concept was found beneficial especially for Z-generation because "they are more comfortable with sharing data". Having followers on social media was also given as an example of gamification. This example shows no rewards but just competition. Therefore, the reward in this concept was addressed as even better. However, some concerns such as "too many suggestions might make users feel stupid or tired of it" were asserted. One expert highlighted the importance of frequency of consumption and personal interest. Basically, it is essential to make meaningful suggestions for you. It can suggest a lately opened place. Users can feel the privilege to discover that place first, and the business can be successful easily.

Decisions were taken in the following issues:

- Rewards can be enhanced, such as discounts, tax payment alterations, trial opportunities for bikes or scooters.
- Give priority to natural homemade food, healthy, vegan, local restaurants.

Table 43. Feedback for concept objective 6

Concept Objective 6 – Concept Solution A - Feedback

Opportunity	1. Having more followers in Instagram is also an example of gamification. Users share many things via social media. There is no reward but competition. So, this is also valid. The reward in this example is visibility and even privilege. 2. If they have any kind of return from their actions no matter if it is a free ticket or not, this will be effective. 3. When Pokemon game released at that time, most people lost weight even though the aim was just to play the game. If the objective here is to promote people to walk or bike, and as a return give them small rewards, it will work.
Barrier	1. It would not be possible. No one can give you anything free of charge. If you offer free ticket to someone, that brand, company, community whatever would ask for advertisement.
Recommendation	1. User can set a goal and try to accomplish it, not only the system suggestions. 2. Could be not only free ticket but discounts, tax payment or trial opportunities for bikes.
Concept Objective 6 – Concept Solution B - Feedback	
Opportunity	1. Better if you're out of your town or tourist. 2. Z-generation is more comfortable with sharing data. 3. It is better for the product to be beneficial for sustainable economy.
Barrier	1. Earning just points is not enough and might not be seen as a reward. 2. Being notified all the time could be tiring and annoying. 3. Too many suggestions might make user feel stupid. 4. It can cause addiction. Users will be looking at the screen instead of enjoying the day.
Recommendation	1. Better to filter the data user would like to get. For example, "only seafood restaurants" 2. It should be vegan food or natural home-made food. 3. It should not be limited with healthy or vegetarian food. 4. This wearable can be a product that you can rent as a tourist when you rent a bicycle. 5. Frequency of consumption and personal interest is important here. It is important to make meaningful suggestions for you. It can suggest a lately opened place. User can feel the privilege to discover that place first, and the business can be successful easily.

7. Provide alternative option for mobile phones: Under this concept objective, we proposed one product characteristic as a possible solution (Figure 55). The fashionable wearable is a smart half-glove with a foldable and touchable screen. The textile itself is the screen. When it unfolds, the size of the screen provides an experience just like an average phone screen. The product will work as an alternative phone that the user carries all day without putting it inside pocket or bag.

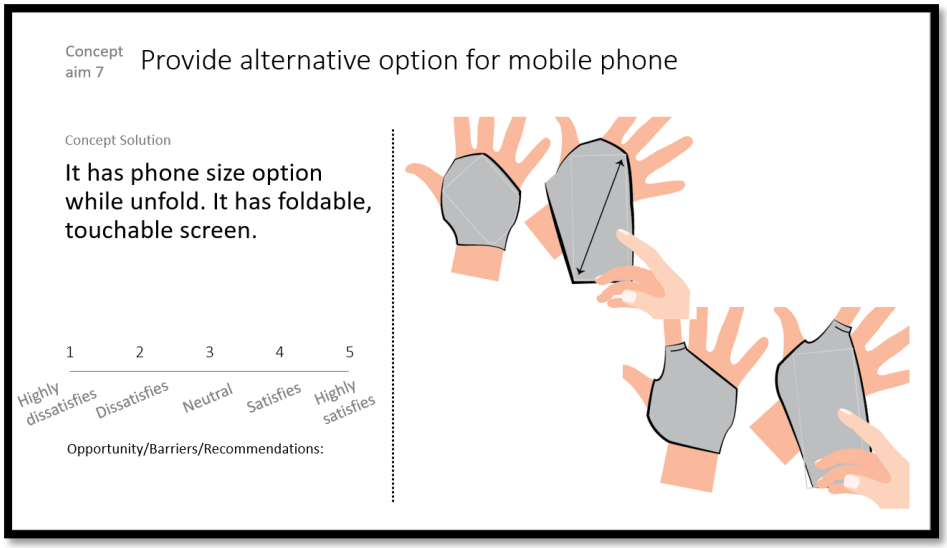


Figure 55. Expert Discussion Card for Concept Aim 7 – Solution A

Feedback: This topic was the most discussed topic among others (Table 44). There were opposite opinions about this matter. Some of the opportunities were listed as "the reason why we don't have this is we don't have enough technology now", "looking inside of the palm is not new for the user which makes it acceptable", "better to be wrapped around the hand to prevent dropping or forgetting the phone on somewhere", "smart phones are still fragile and transform it into foldable and touchable textile can satisfy users", and some others. Drawbacks were also listed as: "in a regular position of the hand, some part of the screens might not be seen", "it can cause discomfort while typing", "durability of the screen is the question", "external product like Google Glass which didn't work out", "not invisible enough", and some others. Experts also suggested that the wearable could be an implant in the future or could be just a display like a screen share but not the phone itself.

Decisions were taken in the following issues:

- Work on technical details and stay with the idea

Table 44. Feedback for concept objective 7

Concept Objective 7 – Concept Solution A - Feedback

Opportunity	1. Looking inside of the palm is not new for user. We hold our phones with similar gesture. 2. User need to hold it and try not to forget it, or put it inside of their pocket. Better to be wrapped around your hand so that you prevent dropping or forgetting it on somewhere. 3. Very logical. The reason why we don't have this is we don't have enough technology now. There are flexible screens but if it offers same speed, same resolution I would definitely want something like this. 4. Smart phones are inside of our life and it is fragile so why not to transform it? Anything

	smart can provide users smart phone feature. This foldable and touchable screen that has same features would actually really satisfy users. So, they don't need a smart phone anymore. 5. Phones can be stolen. This version is better for security. 6. With today's technology, the batteries, and other components may need extra space in this glove so defining a role that only as a screen reflector or controller might help. Also, the components' size will get smaller in the future.
Barrier	1. Users might not consider to turn the hand and make the screen bigger. To see and be informed by single screen seems easier for us. User may not use this product in the way you suggest, they might try to hack this. 2. In regular position of hand, some part of the screen might not be seen properly. 3. Depends on durability of screen. 4. We are not sure if smart phones will be in the same format in the future. You can consider this as an alternative for mobile phone today, but future technology may provide you something that far beyond our imagination. 5. It can cause discomfort while typing when you open it. 6. Screen is something that we owe in different forms like phones, TVs, PCs, projections today. Integrating a screen on hand or palm is not an incredible improvement. It might not be necessary. 7. Google Glass didn't work out. That product was external. Yours is the same. It has to be invisible on the body. Yours is not invisible enough.
Recommendation	1. Consider to solve everything on the face of hand not inside. 2. Consider left-handed people. You can produce this with a double-sided screen. 3. Place a material under the screen that stables the soft fabric while on opened screen. 4. Could be an implant in the future, like the hand is the phone itself. 5. This product can be an interface, or display for a mobile phone. So, all power or capacity, elements are inside of the mobile phone, but this wearable can be a display like a screenshare. 6. They are working on implantable brain–machine interfaces (Check Neuralink) We should get more benefit than just a screen if this is a product embedded on our body.

8. Provide solution for battery issues: One concept solution was provided for this concept objective (Figure 56). As mentioned in previous concept details, the concept system has other smart clothes. These clothes have solar fibres in default and provide solar energy for the wearable. The smart glove connects to worn garments or bikes, or other city elements to use solar energy when it has a low battery.

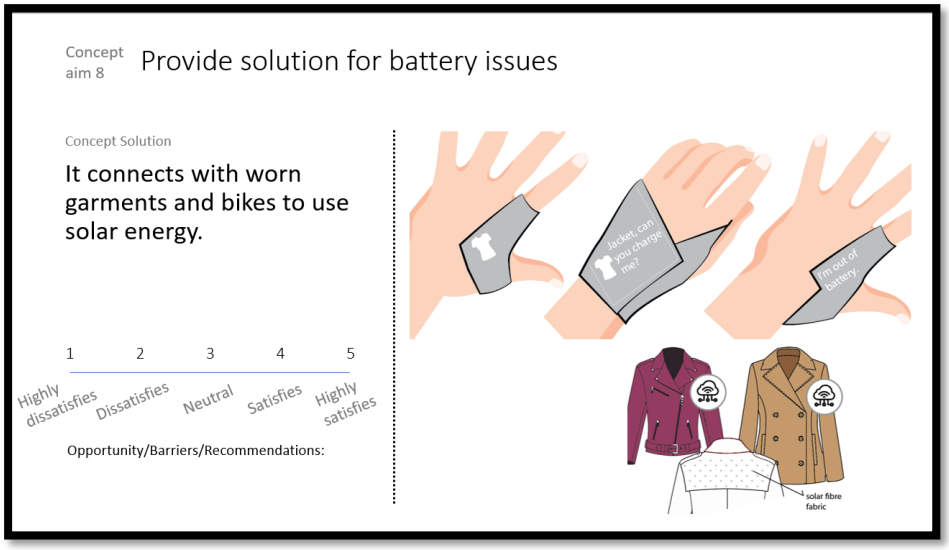


Figure 56. Expert Discussion Card for Concept Aim 8 – Solution A

Feedback: There were also plenty of different contrasting opinions on this topic (Table 45). Some experts found it useful to charge the product with something you carry with your body. Additionally, they gave recommendations as it can charge itself with its own solar fibres, connect to other people's garments, motion energy of bike while biking. Some experts were defended that battery issues will be solved as not better systems to charge the battery but better batteries that do not even need to be charged in the future.

Decisions were taken in the following issues:

- Charge itself with its own solar fibres or other city elements in seconds wirelessly

Table 45. Feedback for concept objective 8

Concept Objective 8 – Concept Solution A - Feedback

Opportunity	1. In technical textiles exposition, they have already had some yarns to do battery charge. Solar fibre is not that complicated anymore. 2. Wireless charging existed for so long. Smart furniture had same feature in 2013. There was a surface on furniture for your phone to charge. You just put it on. 3. We started to touch screens within 2011. Our interaction with mobile phones changed recently. This is not far away. 4. Nice to have an option to charge this with something that you carry with your body. 5. People can check their city map to look for wireless charge stations. They can walk to the stations so this can also encourage walking. 6. You can make this by induction. If you have solar panels on back, you can have capillary cables (not real cables, print or fabric) inside sleeve. If you wear this jacket with one conductor inside the cuff, and the other one inside the glove, then problem solved. Since they are close, glove can be charged, and communicate. 7. Solar panels also work fine in cloudy weather. In the future, the efficiency of this system would be much better.
Barrier	1. The most frustrating part for this smart future is the battery technology and physical

	boundaries of human. 2. Depends on how much energy wearable needs. 3. Solar solutions are not washable today. Conductive yarns are washable for instance but the problem is the stability of the connectivity. 4. Battery issues will be solved as not better systems to charge the battery but better batteries that don't even need to be charged in the future. 5. It doesn't make any difference to find solution for the energy with sun or an unknown particle. This is a requirement and, in the future, this will be solved. Just like developing vaccine in an impossible duration in pandemic. 6. That magnetic field might be harmful for human. 7. Battery is a real trouble. The only batteries you can recharge in today's technology is Lithium-ion battery. And you have to be careful about pressure, heat and others.
Recommendation	1. It can show the clothes user wears that day. It can connect to any of them without asking. 2. It can connect to someone else's jacket with permission. 3. Can't it charge itself with its own solar panel? 4. Design this solar fibre parts modular. Not to have this in your clothes on default. If it fails somehow, then you will lose the whole jacket. 5. Consider other accessories as a solar resource, like necklace, belt, backpack, hat, pocket, zipper puller, buttons. 6. Some watches charges itself with a kinetic energy (moving your hand). It is an old technology. So, some other solutions can be thought in the future. 7. User can also charge it by the motion energy of bicycle while biking. While holding the handlebar of bicycle, they can charge it. 8. Consider watch batteries shaped as a button or coin according to the feature of the wearable.

9. Provide an alternative for transportation card: For this concept objective, we defined one concept solution (Figure 57). In this concept, the fashionable wearable has IoT and NFC technology, and it interacts with bike-sharing stations. When in interaction, application occurs on the screen and users can quickly charge or pay for the trip. In that case, there will not be a need for different applications for different bike-sharing brands.

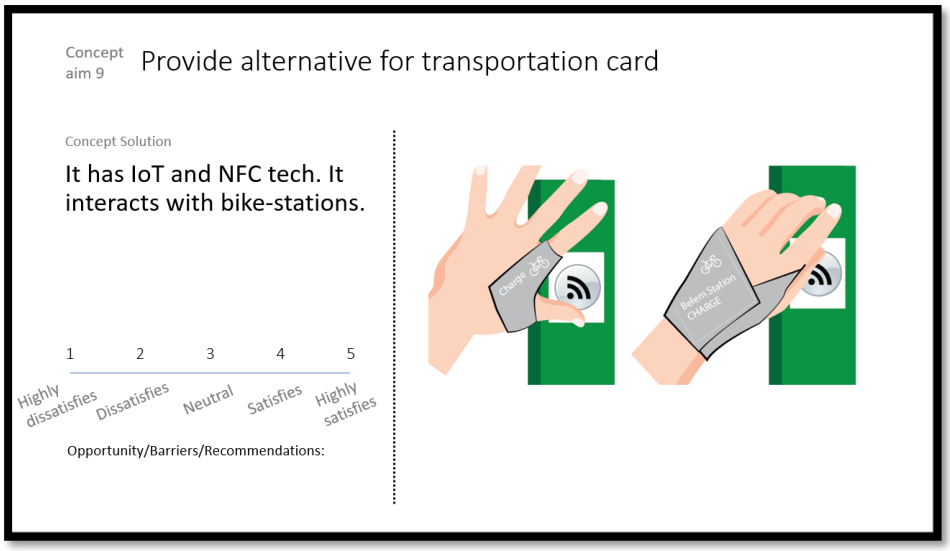


Figure 57. Expert Discussion Card for Concept Aim 9 – Solution A

Feedback: This concept was accepted and positively evaluated by all experts (Table 46). They basically found it practical and logical; however, it might be hard to define how to do this.

Decisions were taken in the following issues:

- Continue with the idea

Table 46. Feedback for concept objective 9

Concept Objective 9 – Concept Solution A - Feedback

Opportunity	1. It is frustrating for users to download different apps to use scooters or bikes in the city. It is an obstacle for that company. If you avoid starting conditions, this is meaningful. It is practical and facilitates sustainable options. 2. Bank cards, identity cards, driving licenses and others are becoming one simple card or system. This is the same. 3. Finance technologies are already doing it by uniting all bank accounts or credit cards. It is hard to do in practice now, but still valuable and important.
Barrier	1. Hard to define how to do this.
Recommendation	1. Not a good idea to monopolize the systems. There are lots of alternatives, so the idea should be only to see different companies on the same interface.

10. Provide security for possible danger: In this final concept objective, we proposed one solution (Figure 58). In possible danger such as a car is coming towards a user, the wearable connects to the worn garment and sends vibration warning on the side of coming car. The wearable itself might vibrate as well.

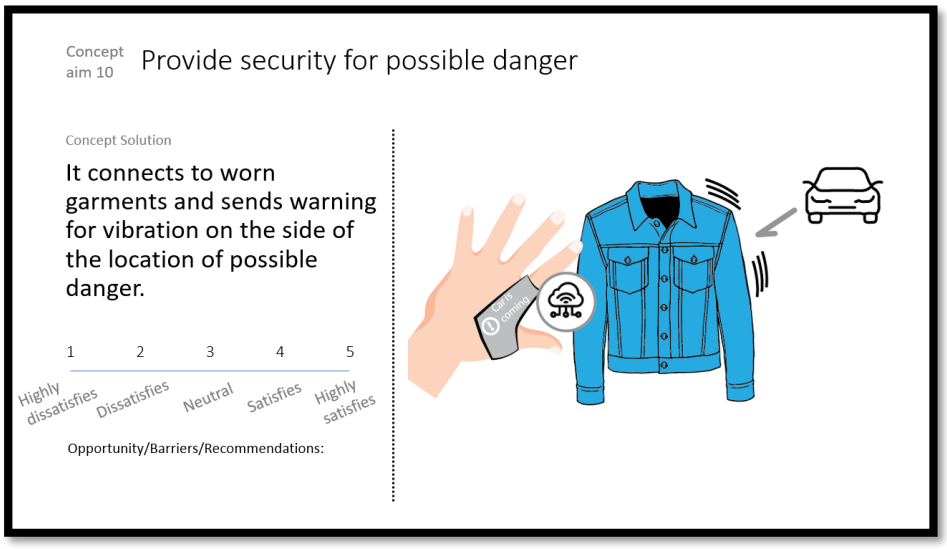


Figure 58. Expert Discussion Card for Concept Aim 10 – Solution A

Feedback: Experts had different opinions about this solution (Table 47). Although the general idea of sending a warning in possible danger was found beneficial, the form of feedback was criticized as it might be disturbing, it could be hard to arrange this system, plus it might cause more danger. Mainly, recommendations were to change the form of feedback and consider audio, light or colour change warnings. Vibration might remain in the wearable itself. Besides, experts also claimed that the warning should be given to the car driver since it will be a smart environment and vehicles can connect to each other.

Decisions were taken in the following issues:

- Eliminate vibration of clothing
- Consider giving warnings to car drivers

Table 47. Feedback for concept objective 10

Concept Objective 10 – Concept Solution A - Feedback

Opportunity	1. Electric cars are very silent. It is almost impossible for the user to understand there's a car nearby if it is not on your sight. 2. It is possible to measure your possibility to crush with a bike. Because it knows your velocity, acceleration or road. 3. In the future, we can produce washable electronics. 4. Feedback can be given in different and more effective forms. It is meaningful. This feedback might be more effective than any others since you feel it on your body. The skin has real potential. It has the widest surface area. You can heat, cold, vibrate or more.
Barrier	1. User will be in action, so it might be difficult to perceive the vibration. Hard to sense which side is vibrating if it is not stretched clothing. 2. Could be dangerous. This might frighten the user or cause stress or distraction while biking or running. 3. This system might give warning to cars, and drivers can see on their head-ups. Smart cars or autonomous cars will be smart enough not to cause any accidents. So, in that case, you wouldn't need this warning. 4. Users depend on the machine and get used to not paying attention.
Recommendation	1. Think about different feedback forms. Could be an audio warning or light. Clothes might change colour as a warning. 2. For the vibration, you can put modular electronics, and you can take it off when you need to wash the jacket. 3. Consider to warn the car driver. Cars are also getting autonomous. As an outcome of machine interaction, they will be able to understand the biker or pedestrian nearby. 4. This warning might be given when the biker needs to turn left or right, on dangerous curves, needs to pass car road, or cross the streets but not all the time. 5. Consider a clothing as an alternative airbag. There are jackets that turns into an airbag when you are about to crush while driving a motorcycle. You don't need a helmet for that. You wear it and it opens in need.

3.3.4.3 Section Conclusion

As a final remark, expert concept evaluation provided us a range of different perspectives not only specific to the conceptual design we developed but also future foresights and feasibility of ideas. Surprisingly, some of the ideas such as colour changing fabrics, flexible and tiny batteries, flexible and thin textile screens, even a piece of fabric that works as a smart phone without any cables were all found feasible in the near future (2030s). They even proposed hologram technology, e-skin technology, e-textiles that replicate skin colour for invisibility and some other innovative materials and ideas on the concept. They mainly highlighted that these technologies were not that far away and most of them were already developed and prototyped; however, they needed to be enhanced.

The most frustrating part for this future smart concept was indicated as the battery technology and physical boundaries of the human. Even for the battery issue, on the one hand, they said: "Today's technology is Lithium-ion battery which is a big trouble and barrier, is sensitive to pressure, heat and other factors". On the other hand, they also said that this issue would be no longer an issue because this is a requirement. Developing a vaccine in an impossible duration in pandemic conditions was also given as an example.

All in all, concepts, ideas, technology possibilities, future foresight were all discussed in these expert interviews. The conceptual design was evaluated in a positive way considering feedback from experts. The concept was found to have potential. Some highlighted statements regarding this potential were:

> *"People are not rational to think about the comfort. If we are, we won't be consuming half of the products today. This product can be a symbol for identity. This may have a semantic meaning."*
>
> *"Feedback can be given in different and more effective forms. It is meaningful. This feedback might be more effective than any others since you feel it on your body. Skin has a real potential. It has the widest surface area. You can heat, cold, vibrate or more."*
>
> *"Smart phones are inside of our life and it is fragile. So, why not to transform it? Anything smart can provide users smart phone feature. This foldable and touchable screen that has same features would actually really satisfy users. So, they don't need a smart phone anymore."*
>
> *"This data can have a collective meaning. It has a potential to make user more consumable. Based on this information, user might be more acceptable in the society. If it is seen from the perspective of political correctness, this is important."*

Some concerns might be considered as limitations for the concept. Related statements were mainly the difficulty in speculating for the future:

> *"We are not sure if smart phones will be in the same format in the future. You can consider this as an alternative for mobile phone today, but future technology may provide you something that far beyond our imagination."*
>
> *"It is hard to perceive technology and recommend something. We might be using products that we cannot imagine today."*

However, it must be highlighted that the future context of smart cities and other emerging technological environments, wearables and other smart products were foreseen in the near future by various consulting companies and trend analysis reports. Those were also shared in Literature Review Chapter. Therefore, these concept ideas were developed based on emerging trends that were presented in the literature.

Based on recommendations and other feedback from experts, we made decisions and some minor alterations to the concept. The final version of the conceptual design will be presented in the next and the final part of this phase.

3.3.5 Conceptual Design Development

Benefiting from the previous part's results and discussions, we made alterations on our conceptual design. The smart half-glove is the major product of the concept (Figure 59). The system consists of other smart things such as city elements (bike stations, bus stops, schools, markets, museums,…), accessories (earphones, shoes, hats, …) and clothes (jacket, t-shirt, pants, …). They all have IoT connections between them. Smart half-glove has two size options for small and big hands. Spandex blended fabric will facilitate movement and efficient cover. We also sketched some other forms of smart half-glove to emphasize that wearable's form could be shifted into others with the help of a comprehensive user experience study.

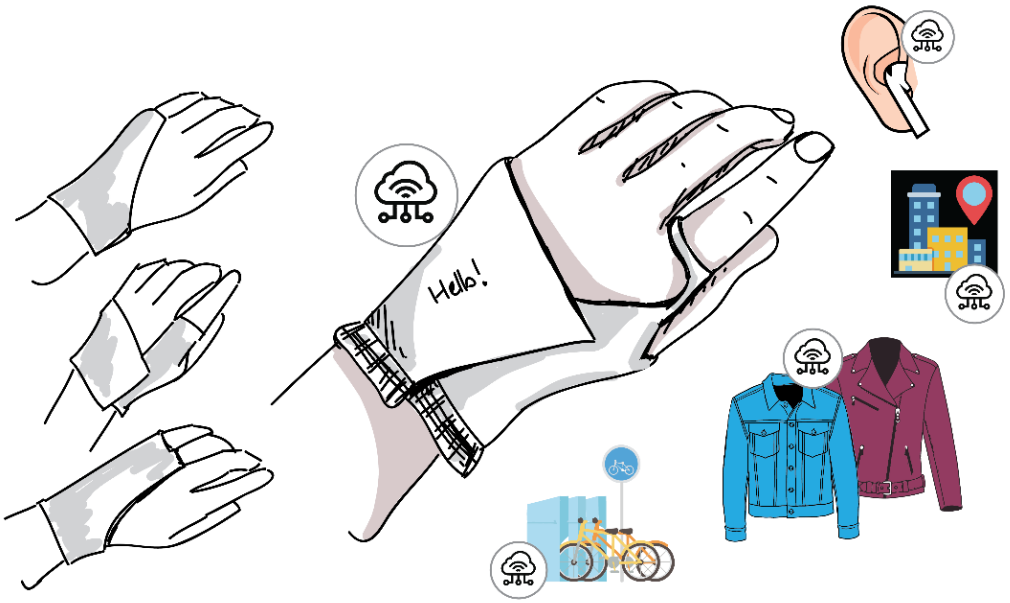


Figure 59. Concept environment

Figure 60 illustrates other characteristics of the fashionable wearable. The smart half-glove form that we designed for this particular environment has 3-point support: thumb, point finger and wrist. It has fabric texture and modular styling pieces (rib fabric, lace, elastic bands,…). It is thin and light-weight and covers the hand, changing its colour or pattern in need. Additionally, it is detachable to the upper part of body clothing from the sleeve part.

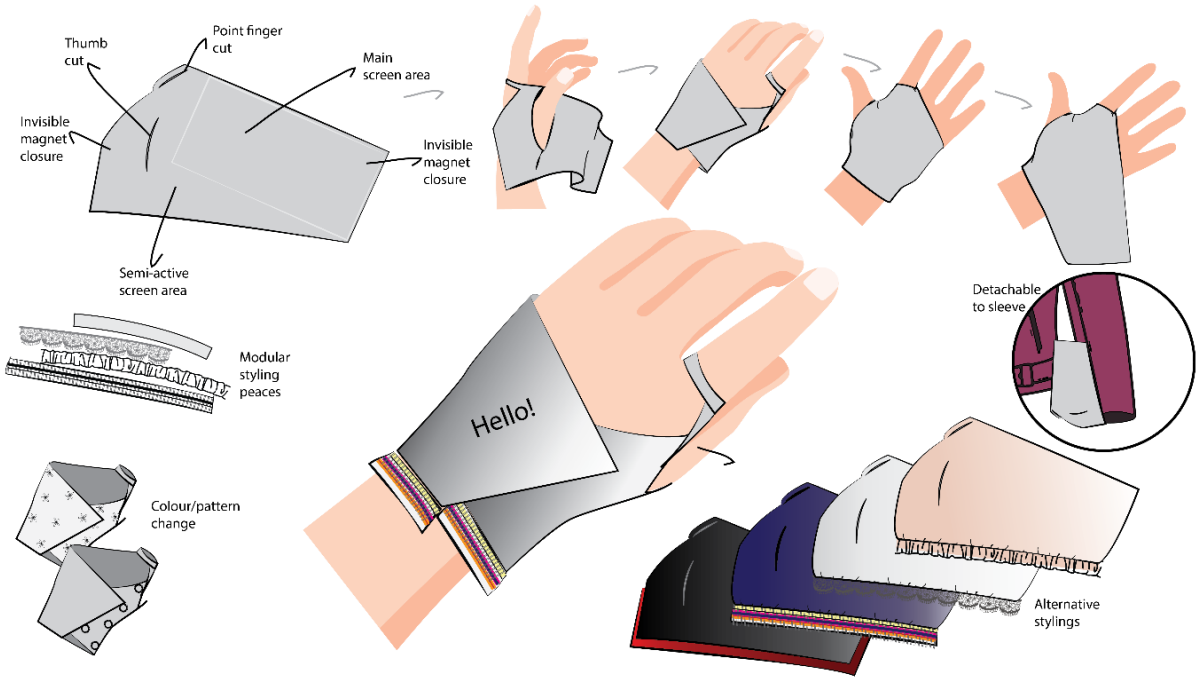
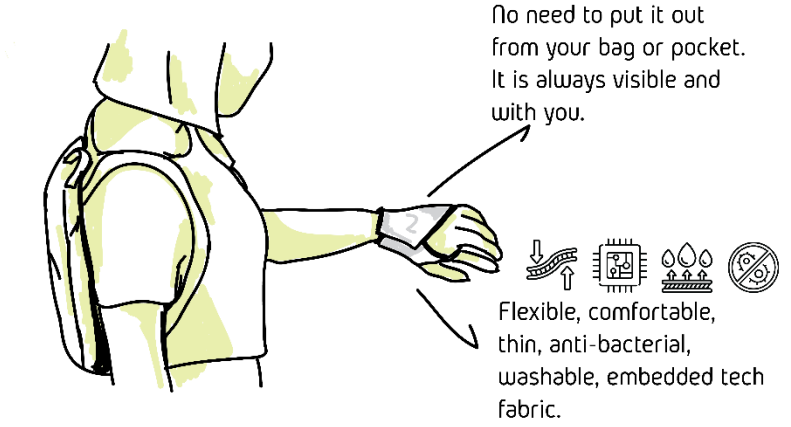
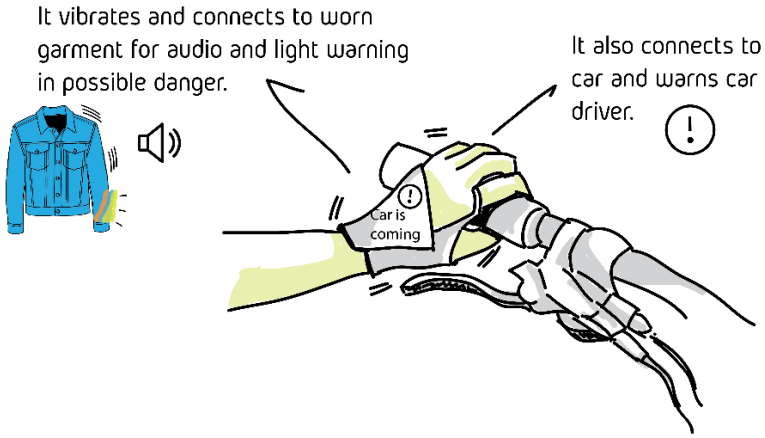
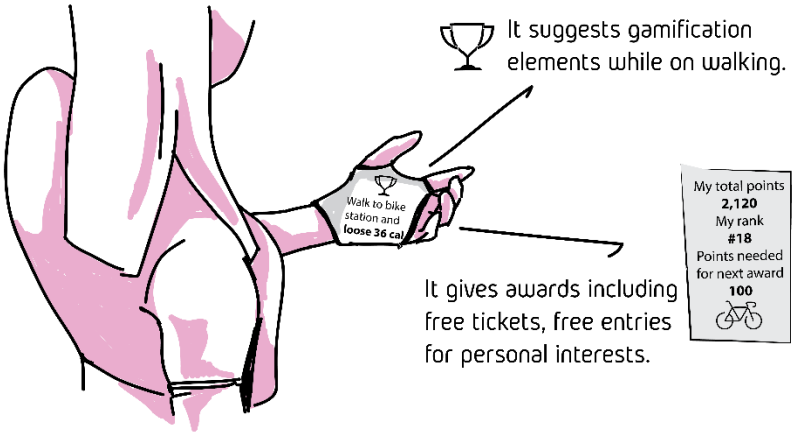
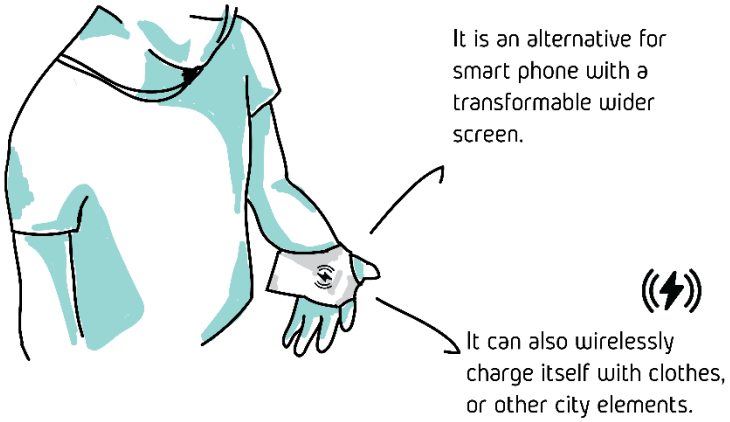
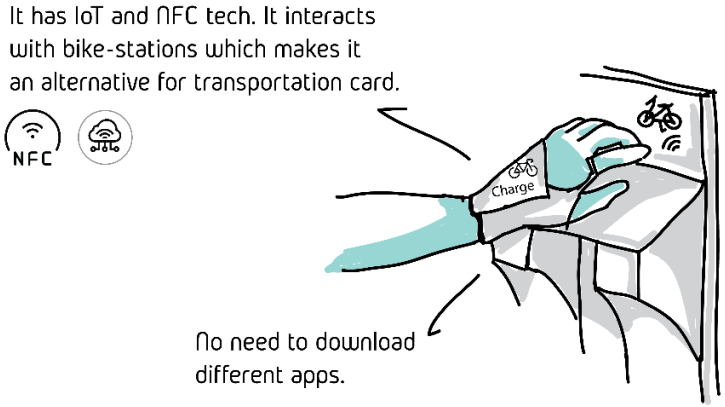


Figure 60. Fashionable wearable concept

The rest of the conceptual design offerings were illustrated as solution storyboard frames in the following Table 48.

Table 48. Conceptual design in solution storyboard frames

	Solution storyboard frames
1	
2	
3	

4	
5	
6	

4.3.5. Overview of Key Findings

Key findings from Phase Three are demonstrated in the following Table 49.

Table 49.Results and outcomes of Phase Three

Persona and Scenario	**Concept Generation and Ideation**
Results/Outcomes:	Results/Outcomes:

1. 3 personas were created to represent user profile: Ana “attracted/interested” Maria “concerned/not interested” Daniel “temporary user/traveller” **2.** Problem scenario was structured to represent problems and demands of users.	**1.** Concept requirements were identified: • Behaviour strategies (DfBC Tool) • Body ergonomics, perception, functionality, technology/energy, materials/recycle • Key factors of fashionable wearable construction • Inform, motivate, enable, feedback, remind, create goals, reward, make it easy **2.** Storyboard frames matched with concept solution ideas **3.** 10 concept objectives were determined and matched with requirements and problem topics **4.** Conceptual design was generated. We decided to design the concept with a key smart element which is a half smart-glove.
Expert Concept Evaluation Results/Outcomes:	**Conceptual Design Development** Results/Outcomes:
1. Concept ideas and solutions were found satisfied enough to reach considered goal. (According to mean values) **2.** Highly rate concept idea was providing alternative for transportation cards and creating a holistic digital card/fashionable wearable with embedded communication technologies. **3.** Least rated concept idea was vibration alert of wearable when in dangerous situations. **4.** According to feedback, conceptual design was improved.	**1.** Solution storyboard was created and conceptual design was finalized.

In this phase, we created three personas and one narrative scenario to effectively represent user profiles, user demands and problems. Our three personas took part in the scenario of their one overlapping day with full of problems that they faced. Storyboards were illustrated and brainstorming, mind-mapping and sketching techniques were used to generate conceptual design. During conceptual design, we used Design for Behaviour Strategies and considered the key factors of designing fashionable wearable. The type of fashionable wearable was selected as “arm-wear” benefiting from literature review results and persona needs. As a final step, we conducted expert interviews to assess the conceptual design and provide guidance, feedback and suggestions to improve the concept we designed.

After all the discussions we had with experts, the key product of the conceptual design remained the same. However, we tried to emphasise the system and the solutions around the smart product. The intention of this phase is to find solutions using the behaviour strategies to influence the target behaviours. We shared all discussions of the conceptual design to provide multiple opinions, either found a place in the concept or not. Designing a concept with a smart half glove might be seen as another product to be consumed which contradicts sustainability. However, convincing people through this fashionable wearable has a different positive impact. According to European Environment Agency, the transport was responsible for a quarter of the European Union's total CO_2 emissions in 2019, of which 71,7% came from road transportation. Cars are a major polluter, accounting for 61% of the road transportation (Erbach, 2022). Our target mobility behaviours were non-motorised ones that contribute to reducing carbon emissions and achieving climate neutrality by influencing people. Motivating people for this purpose eventually can change the behaviour of society. Even minor changes on this matter are essential to serving this purpose.

Walking and bike-sharing not only reduce carbon footprint but also implement a healthy behaviour in everyday life. According to World Health Organization, physical inactivity contributes to over 5 million preventable deaths worldwide each year (WHO, 2020). It is also highlighted that walking and cycling have the potential for regular physical activity on a daily basis; however, their role and popularity are declining in many countries (WHO, 2018). The conceptual design of fashionable wearable may impact the environment in some aspects but also cost benefit by influencing sustainable behaviours that contribute further.

3.4 Phase Four: Prototype

In the previous phase, we finalized conceptual design based on evaluation of experts. Before meeting users, we created prototypes for visualizing fashionable wearable and the future smart environment around the key smart product. Concept product which is fashionable wearable, was placed in the near future context (2030s) that requires to fulfill characteristics and factors of smart city concept of Giffinger, et al.'s (2007). Therefore, we decided to design mock-ups and Wizard of Oz prototype which fakes the smart technology offerings of the wearable with computer animation to visualize the future smart environment.

3.4.1 Methods

The following methods were used in Phase Four:

Mock-up: Mock-ups are design tools that visually explains an idea or service concept (Moritz, 2005). Mock-ups are useful for architects and interactive system designers, providing three-dimensional illustrations (Beaudouin-Lafon & Mackay, 2007). There are different ways of representing a product. While wireframes mostly represent a product's structure, a mock-up shows how the product will look. Unlike wireframe, it can be either mid or high-fidelity display of design with low functionality (Mkrtchyan, 2018; UXPin, 2015). The benefit of mock-up is to help make final decisions regarding the product's colour, schemes, visual style, typography. They are also identified as "off-line rapid prototyping techniques" that do not involve software; however, these tools are mainly considered for thinking through design issues.

In our study, we created mock-ups to provide users a visual representation of our product in a possible high-fidelity display with low functionality. Thus, we were able to represent a future concept product and better explain and discuss the idea.

Wizard of Oz Prototyping: There are various types of prototyping depending on representation, precision, interactivity and evolution (Beaudouin-Lafon & Mackay, 2007). "The idea of prototypes is to provide fast and easily changed early view of the envisioned interaction design" (Hartson & Pyla, 2012). In this sense, it covers any method that visualizes or describes an idea, including photos, illustrations, cartoons, storyboards, flash videos and simulations, videos, paper prototypes, and others that can be used (Kraft, 2012). Wizard of Oz is essentially a "fake it until you make it" strategy that allows you to create the fabrication of ideas when it is impossible to realize the vision because of not enough time or limited resources (UXPin, 2015). This method was initially used to develop natural interfaces, and the principle was like this:

> *A user sits at a terminal and interacts with a program. Hidden elsewhere, the software designer (the wizard) watches what the user does and, by responding in different ways, creates the illusion of a working software program. In some cases, the user is unaware that a person, rather than a computer, is operating the system* (Beaudouin-Lafon & Mackay, 2007).

However, Beaudouin-Lafon & Mackay (2007) also argues that the main idea behind the method is giving users the impression that they are working with a real system before it

exists. A combination of video and software can work well to make that impression, depending upon what needs to be simulated.

In our study, the conceptual product needed future technology components that we were unable to embed in the fabric in current circumstances. To overcome this limitation, we made pre-computed animations on the fabric with the help of video editing software. Thus, we created a sort of video prototype that was able to give users the impression of being a fully functional actual product.

3.4.2 Mock-ups

This part of the phase was conducted in 2 steps:

Preparation for mock-ups: First, we searched for textile materials that would fit best for the fashionable wearable considering the closest looking appearance based on final visual decisions that we made in previous phase. After, we prepared pattern-making for the half-glove and made trials for improvement. Finally, we obtained the materials and started to construct. Figure 61 shows some frames of procedure in this step.

Figure 61. Mock-up construction procedure

As the main material, scuba fabric was chosen (black and white). For optional versions, artificial leather fabric (skin colour) was used. Those fabrics were easy to cut and sew since they do not fray in nature. As modular styling pieces, we used striped knitwear fabrics with elastic bands inside as ribbing. For the closure of the half-glove, we obtained small coin magnets and tried to sew them inside two layers of fabric.

Development of mock-ups: After obtaining materials, we started constructing mock-ups and made trials with different colours and different styling pieces. All alternative mock-ups were hand-made. Figure 62 shows mock-up trials and different alternatives.

Figure 62. Mock-up trials

Figure 63 demonstrates the mock-up in white colour alternative from different hand positions. Even though we tried to make a high visual low functionality product, we had difficulty in providing excellent visualization. For example, we used double layers to stabilise the half-glove when unfolding. This caused extra thickness and a little bit of wideness; however, the product provided extra thickness, lightweight and perfect cover. Constructing small magnets for the closure part also caused a highly visible stitching mark that we did not want. However, we disregarded it as these mock-ups would be edited with computer animation. Nevertheless, we chose the black colour alternative for a more decent look.

Figure 63. Mock-up trials (white alternative)

3.4.3 Wizard of Oz Prototype

We already explained in the methods section of this phase that the Wizard of Oz approach was basically a “fake it until you make it” strategy that provides creating a fabrication of one’s idea when one is unable to realize the vision (UXPin, 2015). It was almost impossible for us to create a fully working prototype with all technological attachments by reason of not

currently having the technological advancement we needed. As we have mentioned so far, the concept will place in the near future. Therefore, we decided to fake the characteristics of the concept product by “watch only” video presentation using software for animation. In this sense, the prototype would feel interactive to the user and look more realistic than just experiencing mock-ups with no active features.

This final part of the phase was also conducted in 2 steps:

Preparation for video prototype: We already prepared mock-ups in the previous step. We planned to use one of the concept objectives related to the alternative transportation card feature. The interaction of fashionable wearable with bike stations was transformed into simple interface looks that planned to be used as a screen of the product. Adobe XD was used for designing interfaces for simulation and adapted Milan’s (2017) and Ramon’s (2019) UI kit designs and altered them for our scenario (Figure 64).

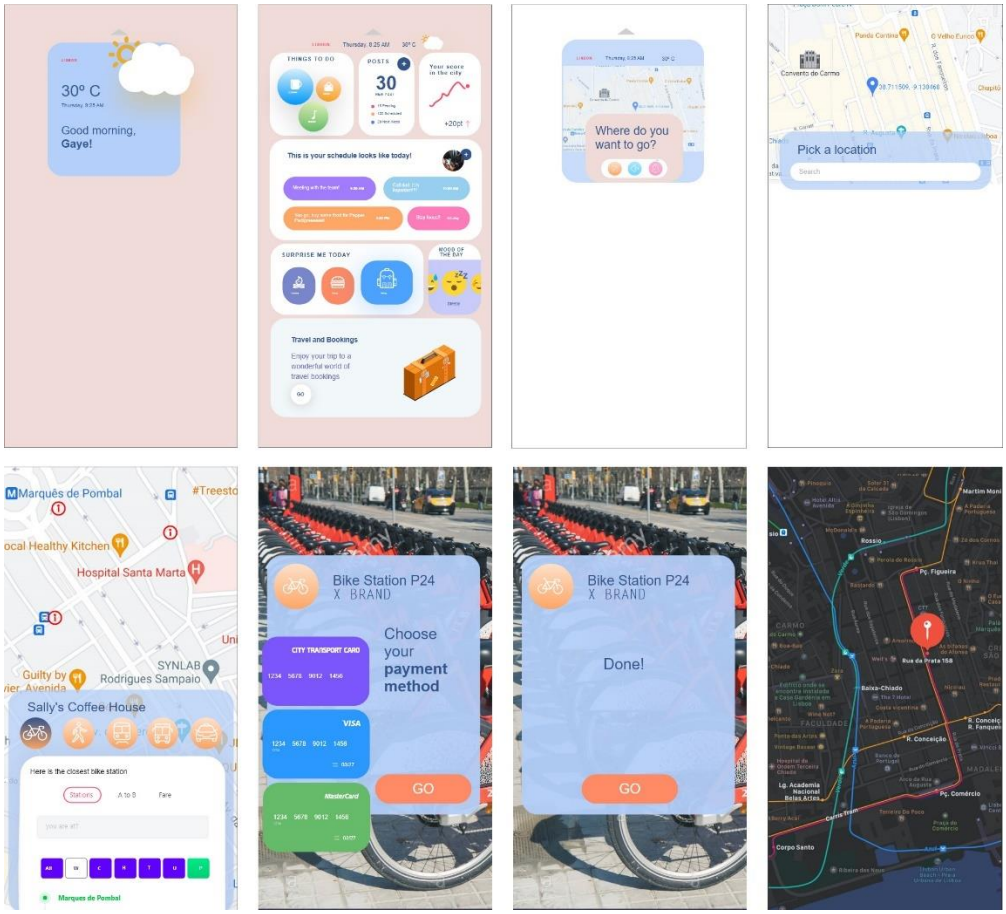


Figure 64. Interface trials

Development of video and animations: After finishing the interfaces, we shot several videos with different mock-up alternatives. We added green screens on mock-ups and made trials

with prepared interfaces for the animation (Figure 65). We faked finger movements in advance and edited videos as if a person was interacting with the fashionable wearable. Animations were made in video editing software called DaVinci Resolve 17. We decided to use the black alternative for screen interactions; therefore, we altered the interface for better visualization. We also used the white alternative for regular use in daily life without any interface displayed on it.

Figure 65. Prototyping process

Figure 66 demonstrates scenes from the video prototype. It started with choosing one alternative, wearing it on, and taking it off to show physical usage details. After, interface interaction was made in the fold and unfolded version. Screen animation was made on both screen sides: on the outer hand and inside the palm. The editing was finalized after adding regular use in daily life scenes between interface interactions.

Figure 66. Scenes from video prototype

3.4.4 Overview of Key Findings

Key findings from Phase Four are demonstrated in the following Table 50.

Table 50. Results and outcomes of Phase Four

Mock-ups Results/Outcomes:	**Wizard of Oz Prototyping** Results/Outcomes:
1. The main smart product of our conceptual design, fashionable wearable was constructed as a mock-up with high visualization and low functionality.	**1.** Realization of future concept features of fashionable wearable was accomplished by video prototyping and additional animations. **2.** Prototyping was finalized to serve for user experience.

Based on sketches and illustrations of conceptual design after expert evaluation, we created mock-ups to visualize the main product of our concept system. Visualization was necessary for the fashionable wearable concept to be also evaluated by its physical appearance. With the help of computer animation and video editing tools, we were able to involve the software and

gave users the impression that they are interacting with a real system before it exits. Therefore, we made the prototype ready for the final phase, which is the evaluation by users.

3.5 Phase Five: Evaluate

In the previous phases, we accomplished prototyping and sensualisation of ideas, concepts and scenarios. This final phase's objective was to assess the conceptual design considering acceptance and perceptions of users and the impact of concept solutions in the context of intervention. We conducted a user experience questionnaire and made a statistical analysis to evaluate attractiveness, perspicuity, efficiency, dependability, stimulation and novelty of the conceptual design. As a final step, we would be evaluating the target behaviour intervention.

3.5.1 Methods

The following method is used in Phase Five:

User Experience Questionnaire: User Experience (UX) is defined as "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service" (International Organization for Standardization, 2019). Additionally, "users' perceptions and responses include the users' emotions, beliefs, preferences, perceptions, comfort, behaviours, and accomplishments that occur before, during and after use" (ISO, 2019). Therefore, UX is a crucial factor to determine the quality of a product or service. Diaz-Oreiro, Lopez, Quesada, & Guerrero (2019) indicate that "to study UX, an essential element is the evaluation, which refers to the application of a set of methods and tools whose objective is to determine the perception about the use of a system or product".

There are different standardized questionnaires, and the User Experience Questionnaire (UEQ) is one of the most recognized (Diaz-Oreiro, Lopez, Quesada, & Guerrero, 2019). Unlike traditional methods that often focus on usability goals or pragmatic quality, this questionnaire also includes hedonic quality aspects (Laugwitz, Held, & Schrepp, 2008). UEQ use semantic differentials to collect the opinion of users regarding the pragmatic and hedonic characteristics of a product (Schrepp, User Experience Questionnaire Handbook, 2019). In our study, UEQ was used as a template for the online user survey to better evaluate the user perception of the conceptual design.

3.5.2 User Experience Analysis

For an extensive evaluation of the conceptual design impact on users, the process of this part was conducted into 3 phases:

Planning and preparation: To analyse user experience, we adapted the User Experience Questionnaire (UEQ) evaluation tool that had already been explained in the Methods Section of Phase Five. Briefly, the questionnaire consists of six scales based on different UX aspects and in total, it contains twenty-six items. Six major scales are demonstrated in the following (Schrepp, User Experience Questionnaire Handbook, 2019):

Attractiveness: Overall impression of the product. Do users like or dislike the product?

Perspicuity: Is it easy to get familiar with the product? Is it easy to learn how to use the product?

Efficiency: Can users solve their tasks without unnecessary effort?

Dependability: Does the user feel in control of the interaction?

Stimulation: Is it exciting and motivating to use the product?

Novelty: Is the product innovative and creative? Does the product catch the interest of users?

In these six different aspects, "attractiveness" is the user's general impression. Other aspects are grouped into two categories: Pragmatic qualities that are "goal-directed" (Perspicuity, Efficiency and Dependability) and hedonic qualities that are "not goal-directed" (Stimulation and Novelty). Figure 67 shows the structure of the UEQ and twenty-six items per scale.

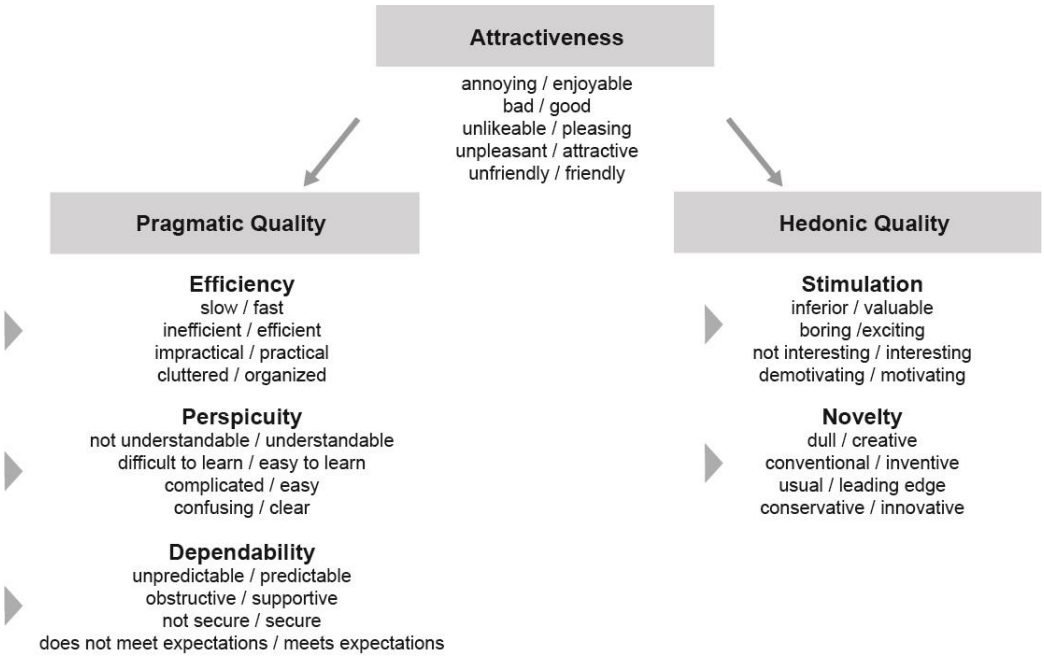


Figure 67. Scale structure of the UEQ (Schrepp, 2019)

Apart from UEQ's semantic differential scale, the questionnaire was prepared to have three parts targeting (1) demographic information, (2) problem scenario introduction and the relation of users in the context, (3) concept design introduction and user experience. We asked additional semantic differential scales, multi-select multiple-choice questions. Additionally, one open-ended question was used to collect feedback or suggestions.

For problem scenario introduction and concept design introduction, we prepared two videos. The first one was 3 minutes video related to personas' some daily problems. Additionally, users were introduced to our personas who live in their future smart city. We used problem storyboards and selected some notable problems in the scenario. Figure 68 demonstrates some scenes from the first video.

Figure 68. Scenes from problem scenario introduction video

The second one was 2,5 minutes video related to the conceptual design solution that we came up with. Additionally, users also saw our prototype, which we accomplished in the previous phase of the research. We used solution storyboards that we introduced a refined version of conceptual design. Figure 69 demonstrates some scenes from the second video.

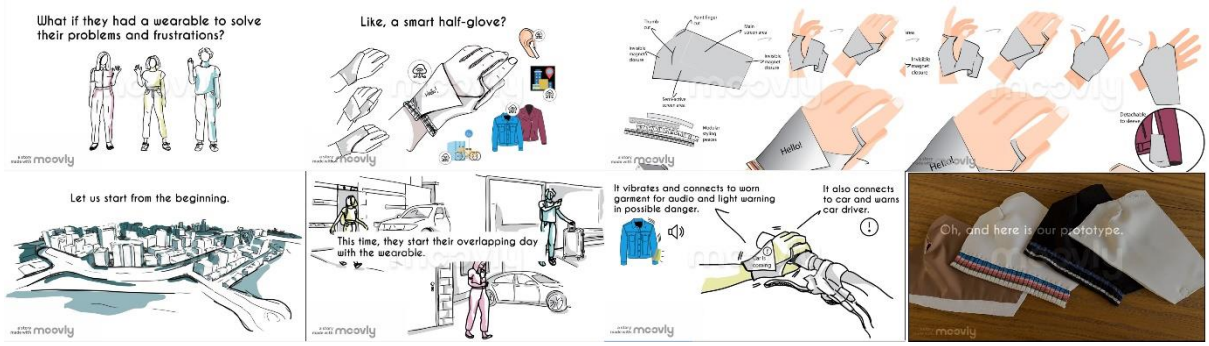


Figure 69. Scenes from concept design and prototype introduction video

Data collection: The questionnaire was designed in English and Turkish via Google Forms, an online software to create surveys (Appendix N). We were able to contact to random users interested in participating, via e-mail, social media, and instant messaging applications. Initially, 149 users participated voluntarily. However, after analysing the data, UEQ analysing tool detected random or not serious answers. The analysis tool checks how much the best and worst evaluation of an item on a scale differs. Such situations can also result from random response errors or a misunderstanding of an item. Thus, it does not consider a response as problematic if it occurs just for a single scale. However, if this is true for two or three scales, the response is found somehow suspicious. We respected the suggestion and removed 18 participants' answers from the data set that shows a value of 3 and higher.

Data analysis and discussion: Questions targeting demographic information and other Likert-scale questions apart from UEQ scale part were analysed with SPSS Statistics software. The results of the original 26 UEQ items and scales were analysed based on user experience tool aspects. Eventually, the last open-ended question targeting user feedback was analysed with MAXqda software. Totally, results were discussed regarding the parts of the questionnaire and intention of questions.

3.5.2.1 Demographics

Table 51 demonstrates the distribution of participants' age and gender correlation. According to the results, the majority of respondents were female (65.4%) and between 28-32 years old (33.8%). More than three-thirds of the participants' (77.9%) age was between 23-37 years old. Furthermore, the overall response was given by users in the range of 28-32 years old. Very few participants (1.5%) were seen as male, 43 years old and older. The correlation between age and gender is worth mentioning because it demonstrates the target group. Since the survey was done voluntarily, we may interpret it as young female adults between 28-32 years old were more interested in the topic. Oppositely, male middle-aged and older-aged adults were less interested in the topic.

Table 51. Users' age and gender profiles correlation

Age	**Gender**					
	Male		Female		Total (∑)	
	Frequency	Percent	Frequency	Percent	Frequency	Percent

18-22 years old	4	2.9%	5	3.7%	9	6.6%
23-27 years old	5	3.7%	8	5.9%	13	**9.6%**
28-32 years old	26	19.1%	46	**33.8%**	72	**52.9%**
33-37 years old	7	5.1%	14	10.3%	21	**15.4%**
38-42 years old	3	2.2%	8	5.9%	11	8.1%
43 years old and older	2	1.5%	8	5.9%	10	7.4%
Total (∑)	47	34.6%	89	**65.4%**	136	100.0%

The other Table 52 shows the civil status and parenthood related results. The majority of the respondents (67.6%) indicated that they were single. We also asked them whether they had children or not, and 86.8% of them responded as "No". We believe that these demographic profiles could also give us an opinion about the relation of the respondents and our personas in later results. We had single, married, and parent personas. These results showed that we had sufficient different background participants that could empathize with the personas.

Table 52. Users' civil status and parenthood profiles

Civil Status	Frequency	Percent	**Having children**	Frequency	Percent
Single	92	67.6%	Yes	18	13.2%
Married or cohabiting with another person	44	32.4%	No	118	86.8%
Total (∑)	136	100.0%	Total (∑)	136	100.0%

The distribution of other demographic profiles; education, and professional status of participants were demonstrated in Table 53 46.3% of users were completed Master's degree, 37.5% of them completed Bachelor's degree. Very few respondents (5.1%) indicated that they were completed high school. The majority of users completed a course of study in higher education, had an academic degree, had experiences with doing research, and it was expected that they paid attention to the questions to better contribute the research. The professional status of participants was indicated mostly as "employed" (72.8%). The percent of "self-employed" and "student" participants were seen as identical, which was 13.2%.

Table 53. Users' education and professional status profiles

Education Status	Frequency	Percent	**Professional Status**	Frequency	Percent

Master's degree	63	**46.3%**	Employed	99	**72.8%**
Bachelor's degree	51	**37.5%**	Self-employed	18	13.2%
PhD	15	11.0%	Student	18	13.2%
High school	7	5.1%	Retired	1	0.7%
Less than high school	0	0.0%	Total (∑)	136	100.0%
Total (∑)	136	100.0%			

Since the study is based on promoting certain types of urban mobility choices, we would like to know more about where participants live. These results highlighted the lifestyle and cultural background of users as well as their habits regarding the opportunities of the cities they live. Table 54 demonstrates the distribution of cities and countries that participants live in separately. The majority of participants live in Ankara (42.6%) and Lisbon (20.6%), which are the capital cities of Turkey and Portugal. Third frequently lived city Istanbul (14.0%), is also the largest developed city in Turkey. In total, 22 cities in 9 countries were found as current residences of users. This study has no intention to correlate cultures or cities with the perception of users. However, we believe that this diversity of cities and countries provided us different aspects from users.

Table 54. Users' current residences considering city and country

City	**Frequency**	**Percent**	**Country**	**Frequency**	**Percent**
Ankara, Turkey	58	42.6%	Turkey	87	64.0%
Lisbon, Portugal	28	20.6%	Portugal	33	24.3%
İstanbul, Turkey	19	14.0%	Italy	7	5.1%
Rome, Italy	6	4.4%	United Kingdom	3	2.2%
İzmir, Turkey	3	2.2%	Germany	2	1.5%
London, UK	3	2.2%	Finland	1	0.7%
Balıkesir, Turkey	2	1.5%	France	1	0.7%
Eskişehir, Turkey	2	1.5%	Iceland	1	0.7%
Setubal, Portugal	2	1.5%	Canada	1	0.7%
Aydın, Turkey	1	0.7%	Total (∑)	136	100.0%
Beja, Portugal	1	0.7%			
Berlin, Germany	1	0.7%			
Bursa, Turkey	1	0.7%			
Caldas da Rainha, Portugal	1	0.7%			
Graz, Portugal	1	0.7%			
Heidelberg, Germany	1	0.7%			

Helsinki, Finland	1	0.7%
Lyon, France	1	0.7%
Milan, Italy	1	0.7%
Ordu, Turkey	1	0.7%
Reykjavik, Iceland	1	0.7%
Toronto, Canada	1	0.7%
Total (∑)	136	100.0%

3.5.2.2 Perspectives of users: Mobility choices and problem relation

After sharing our video that clarifies the context, personas, and problem storyboard of personas in an overlapping day, we asked participants' mobility choices and if they share the same problems of our personas to understand the relation. In response to the multi-select multiple-choice question "Which mobility mode do you mostly use in your everyday life?", most of the participants chose "private car" (78.7%) as it is seen in Table 55. In the problem scenario, after experiencing a day with particular problems, our personas choose to use private cars as a choice of mobility. It was one of the main unsustainable behaviours we would like to avoid. Of course, the creation of personas was based on focus groups and real people problems. This finding also confirmed that both our personas and users had the same habits and issues. Another mobility mode "walking", was also selected as mostly used. Walking was mostly selected with other types such as private car, taxi and public transport. In our view, they may choose it not as a primary choice of mobility but as a supplementary mode for the target mobility choice. Very few respondents (13.2%) preferred "bike or bike-share". The result emphasizes the need for motivation and validity of our research aim. There were 2 participants (1.5%) indicated "electric scooters" in the "others" option that we left empty for different answers. No other suggestions were made in this area.

Table 55. Mobility choices of users

Mobility Types	**Frequency**	**Percent**
Public transport (bus, metro, tram, …)	52	**38.2%**
On-demand transport (Uber, mytaxi, …)	22	16.2%
Private car	107	**78.7%**
Taxi	20	14.7%
Bike or bike-share	18	13.2%

Walk	69	**50.7%**
Other	2	1.5%
Total (∑)	136	100.0%

The other question was asked users to indicate the extent to which they share the same problems as our personas, and the results were seen in Table 56. On a semantic differential scale of 1 to 7, most respondents (27.9%) gave a 5. Statistics also gave information about the mean of results which was found as 5.06. This result further strengthened our confidence in our personas. Personas' problems were found meaningful by respondents.

Table 56. The extent to which users share same problems as our personas

	Sharing same problems as our personas							
	I have none of these problems						I have all the problems	
	1	**2**	**3**	**4**	**5**	**6**	**7**	Total (∑)
F	4	11	11	12	38	29	31	136
P	2.9%	8.1%	8.1%	8.8%	**27.9%**	21.3%	22.8%	100.0%
Statistics:								
Std. Deviation	1.66							
Mean	5.06		F: Frequency P: Percent					
Median	5							

3.5.2.3 User Interests about Fashion and Wearables

The conceptual design that was proposed as a solution to problems, had a smart product in the centre. That smart product was a fashionable wearable that we defined in Literature Review Chapter, and both "fashion" and "wearable technology" perception was important to better understand users. We asked how they rate their interest in fashion and gave a semantic differential scale of 1 to 7. The answers are demonstrated in Table 57. They mostly gave a 5, and the mean was 4.93. Results suggested that participants were interested in fashion; however, only 12.5% defined themselves as trend followers.

Table 57. The extent to which users are interested in fashion

	Interest in fashion

	Not interested						Highly interested & Trend follower	
	1	**2**	**3**	**4**	**5**	**6**	**7**	Total (∑)
F	1	9	10	23	46	30	17	136
P	0.7%	6.6%	7.4%	16.9%	**33.8%**	22.1%	12.5%	100.0%
Statistics:								
Std. Deviation	1.38							
Mean	4.93		F: Frequency					
Median	5		P: Percent					

Table 58 demonstrates the interest and usage level of participants. We basically tried to understand how respondents' relationship with wearables. We asked them if they had any experience with wearable and gave familiar examples such as smart watches and smart bracelets. Pre-determined multiple choices were given. Broadly, 54.4% of respondents claimed that they had experience with wearables either they tried or purchased. Only 6.6% of the total number indicated that they purchased, but they lost their interest. This response could be valuable for us to realise that either users need an enhanced smart product they had experienced or they just got bored of it and they need a totally new smart product. The majority of answers were collected in two statements. One is that they had purchased wearable and liked it. The other is that they had no experience but were curious. These findings demonstrate that a great number of users were interested in wearables which could be interpreted as an opportunity.

Table 58. Interest and usage levels of wearables

Interest and usage of wearables	Frequency	Percent	Cumulative Percent
(1) Yes, I've tried one and I am considering to purchase.	16	11.8%	11.8%
(2) Yes, I've purchased one and I like it.	49	36.0%	47.8%
(3) Yes, I've purchased one but I lost my interest.	9	6.6%	**54.4%**
(4) No, I have no experience but I am curious.	50	36.8%	91.2%
(5) No, I have no experience and I am not interested.	12	8.8%	100.0%
Total (∑)	136	100.0%	

3.5.2.4 Evaluation of Conceptual Design Based on UEQ Measures

The user experience of the conceptual design was assessed in the following sections benefiting from Schrepp's (2019) handbook of UEQ. First, the scales were assigned a value between -3 (the most negative) and +3 (the most positive). Therefore, the seven-stage scale was transformed accordingly. Second, the mean, the variance and the standard deviation of each item was calculated to detect if any item was misinterpreted. Briefly, if an item showed big deviations to the evaluations of the other items of the same scale this could hint that the item was misinterpreted. Last, the values between -0.8 and 0.8 were interpreted as a more or less "neutral evaluation" of the corresponding scale, values > 0,8 as a "positive evaluation" and values < -0,8 as a "negative evaluation". This was applied to single items and scales as well.

Table 59 demonstrates items per scale; mean value, variance and standard deviation. According to the calculations, the standard deviation of the items did not appear high except for three items: Item 3, Item 4 and Item 7. Item 3 (creative/dull) had a 1.9 standard deviation with a mean value of 0.9. Item 4 (easy to learn/difficult to learn) had a 1.6 standard deviation with a mean of 1.4. Item 7 (not interesting/interesting) had a 1.6 standard deviation with a mean of 1.4. Items were respectively in the scale of Novelty, Perspicuity and Stimulation. The other items under these scales were also analysed, and no other high standard deviation (more than 1.5) value was seen. For Item 3 (creative/dull), respondents' answers were spread out over a wider range even though there was a positive mean. Hence, we could conclude that users had different opinions and priorities about the creativity of the conceptual design. (In addition to Table 59, the distribution of the answers per item were also illustrated in Appendix O)

There was no item showing a negative mean, and almost all mean values for each item were rated as positive except one. Item 8 (unpredictable/predictable) with a value of 0.5 showed a neutral mean. Features of the wearable, interfaces of the system, or other system offerings had similarities of other existing smart products and applications such as smart phones, smart watches, sport or health related tracking apps. This could make users think that the idea of the concept is just predictable without any negative impression. Another reason could be being indecisive about the item and which part of the system should have been explicitly judged.

Table 59. UEQ results for per item

Item	Mean	Variance	Std. Dev.	No.	Left	Right	Scale	
1	1,4	1,7	1,3	136	annoying	enjoyable	Attractiveness	
2	1,7	1,6	1,3	136	not understandable	understandable	Perspicuity	
3	0,9	3,6	1,9	136	creative	dull	Novelty	
4	1,4	2,6	1,6	136	easy to learn	difficult to learn	Perspicuity	
5	1,4	2,0	1,4	136	valuable	inferior	Stimulation	
6	1,3	2,1	1,5	136	boring	exciting	Stimulation	
7	1,4	2,7	1,6	136	not interesting	interesting	Stimulation	
8	0,5	2,1	1,5	136	unpredictable	predictable	Dependability	
9	1,3	1,4	1,2	136	fast	slow	Efficiency	
10	1,2	2,1	1,5	136	inventive	conventional	Novelty	
11	1,7	1,5	1,2	136	obstructive	supportive	Dependability	
12	1,6	1,7	1,3	136	good	bad	Attractiveness	
13	1,2	1,9	1,4	136	complicated	easy	Perspicuity	
14	1,2	1,6	1,3	136	unlikable	pleasing	Attractiveness	
15	0,8	2,2	1,5	136	usual	leading edge	Novelty	
16	1,3	1,5	1,2	136	unpleasant	pleasant	Attractiveness	
17	1,0	2,0	1,4	136	secure	not secure	Dependability	
18	1,2	2,0	1,4	136	motivating	demotivating	Stimulation	
19	1,1	1,7	1,3	136	meets expectations	does not meet expectations	Dependability	
20	1,3	1,6	1,2	136	inefficient	efficient	Efficiency	
21	1,5	1,6	1,3	136	clear	confusing	Perspicuity	
22	1,5	1,8	1,3	136	impractical	practical	Efficiency	
23	1,5	1,5	1,2	136	organized	cluttered	Efficiency	
24	1,1	2,1	1,4	136	attractive	unattractive	Attractiveness	
25	1,2	2,1	1,4	136	friendly	unfriendly	Attractiveness	
26	1,8	1,5	1,2	136	conservative	innovative	Novelty	

Figure 70 illustrates all opposite items in the form of a chart. We clearly see that Item 8 (unpredictable/ predictable) has the lowest mean value. The other neutral mean belonged to Item 15 (usual/leading edge). The reason behind it might be interpreted as the same situation for the predictability of the conceptual design. Some of the features and interface/application related solutions might be not found leading edge but offer a bit of novelty than usual.

The highest rated item was Item 26 (conservative/innovative) on the Novelty scale and showed a mean value of 1.8. This high rating confirmed that conceptual design was found very innovative. Despite the earlier findings of Item 3 (creativity/dull), which had neutral mean value under the Novelty scale; remarkably, users found the concept highly innovative. Other highly rated items were Item 2 (not understandable/understandable) with a mean value of 1.7, Item 11 (obstructive/supportive) with a mean value of 1.7, and Item 12 (bad/good) with a mean value of 1.6. Results suggested that the conceptual design was found very understandable, very supportive for the target mobility, and very good in general. Other than the top four rated items, it must be noted as conceptual design also found respectively practical (1.5), clear enough to understand (1.5), organised (1.5), easy to learn (1.4), valuable (1.4), interesting (1.4), exciting (1.3), pleasant (1.3), and efficient (1.3) which were highly above from threshold of 0.8.

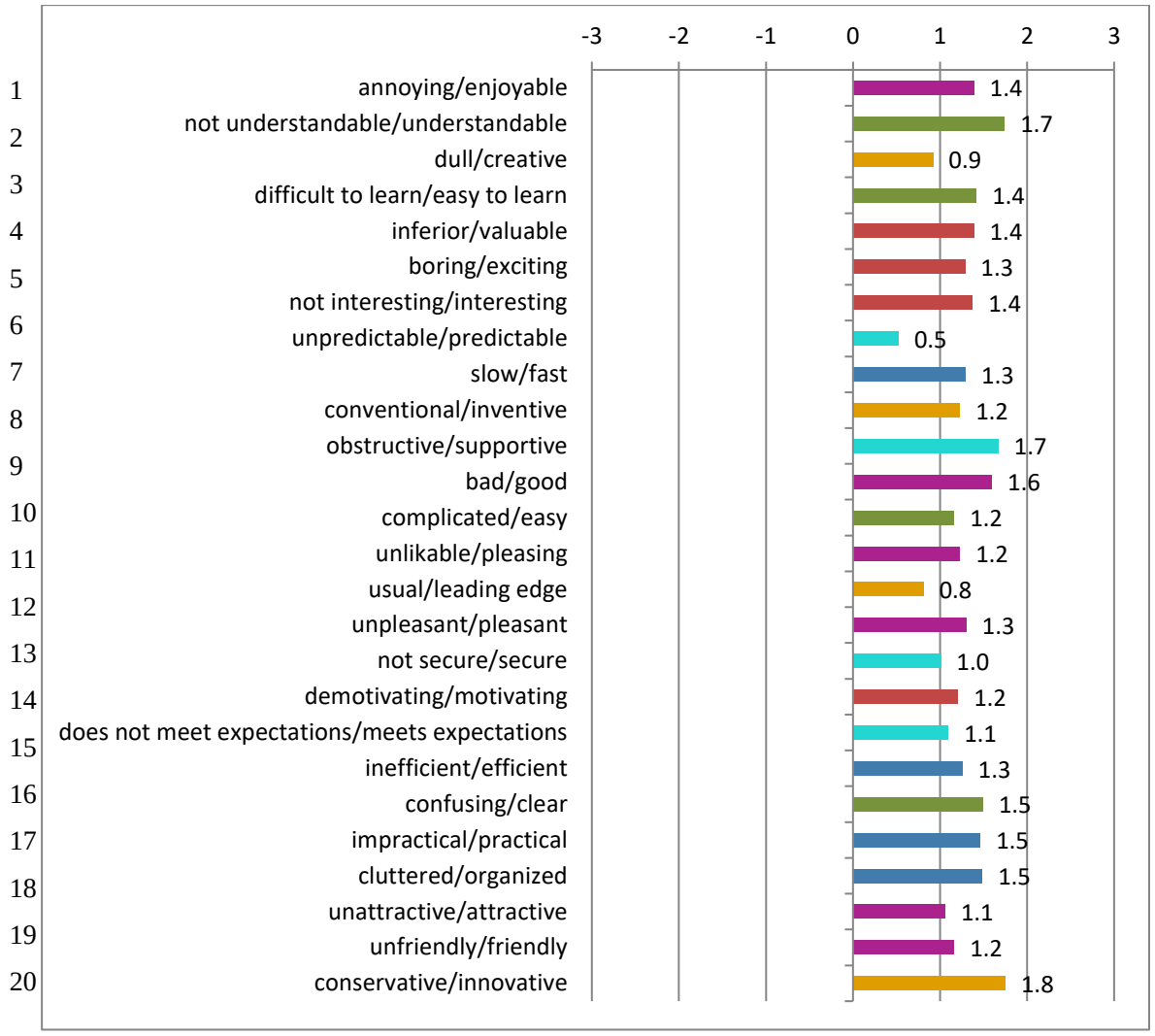


Figure 70. Mean values per items

After analysing single items, the results of six scales in general were also considered. Figure 71 illustrates the mean value of UEQ Scales. Benefiting from the results, it could be interpreted as all scales were perceived positively and the conceptual design created a positive impression concerning all six scales (Attractiveness, Perspicuity, Efficiency, Stimulation and Novelty). Since all the scales were above the threshold of 0.8, the conceptual design fulfilled the general expectations concerning user experience.

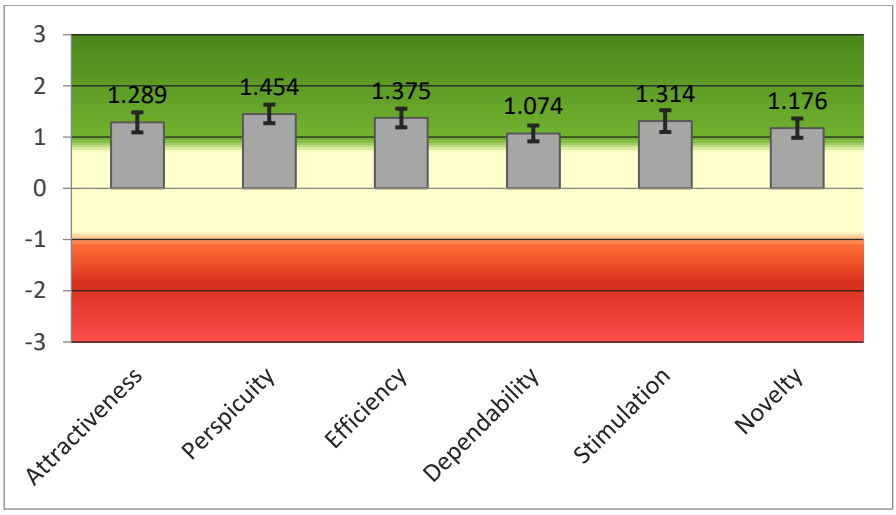


Figure 71. Mean value and confidence interval per scale

Table 60 demonstrates the mean and variance value of six scales. Perspicuity showed a mean value of 1.45 and was perceived as highly positive among other scales. In this sense, we could conclude that the conceptual design was found highly easy to understand, clear, simple, and easy to learn. Next, Efficiency showed the second highest positive mean value (1.38). In other words, users claimed that they could perform their tasks with the concept product fast, efficiently, and pragmatically. The concept system was also found organized. The other, the Stimulation scale, had a mean value of 1.31. This finding could be interpreted as using the concept product and being inside the concept system was found interesting, exciting, and motivating. The Attractiveness scale came just after with a mean value of 1.29. the overall impression of the concept was also positive. The conceptual design and the major smart product were found very attractive, enjoyable, friendly and pleasant. The mean value of Novelty was 1.18, and this scale was ranked slightly lower than other scales. Especially, innovative item of the scale was ranked the most positive evaluation of other items. We could compare with other items and since all items were positively evaluated, we could interpret the concept was innovative, inventive and creatively designed. Dependability showed a mean value of 1.07, which is above the threshold of 0.8; however, the value was one of the lowest among other scales. Interaction with the concept product was found very secure and met the expectations. Plus, the concept was found very supportive of the target behaviour. However, interaction with the concept product or the system was slightly predictable (neutral evaluation), as earlier findings indicated.

Table 60. UEQ results for per scale

UEQ Scales (Mean and Variance)		
Attractiveness	1,289	1,36
Perspicuity	1,454	1,17
Efficiency	1,375	1,18
Dependability	1,074	0,85
Stimulation	1,314	1,60
Novelty	1,176	1,26

As it was already indicated before, the scales of the UEQ could be grouped into pragmatic quality (Perspicuity, Efficiency, Dependability) and hedonic quality (Stimulation, Originality). Pragmatic quality describes task-related quality aspects. It refers to the product's perceived usefulness, efficiency, and ease of use (Mercun & Zumer, 2017) mainly to support the achievement of "do-goals" such as "making a telephone call", "finding a book in an online bookstore", "setting-up a webpage." (Hassenzahi, 2008). Hedonic quality describes the non-task related quality aspects. It considers the joy of use and emphasises stimulation, identification, aesthetics, or emotions (Schrepp, Held, & Laugwitz, 2006). It refers to the product's perceived ability to support the achievement of 'be goals', such as 'being component', 'being related to others', and 'being special' (Hassenzahi, 2008). The combination of pragmatic and hedonic qualities leads to positive or negative emotions and eventually guides the acceptance and the attractiveness of the product. Attractiveness is a pure valence dimension.

The mean of the three pragmatic and hedonic quality aspects were calculated (Table 61). The impression of users concerning the pragmatic quality was slightly higher than the hedonic quality. Both hedonic and pragmatic qualities and overall attractiveness were positively evaluated as their mean values were considerably higher than 0.8. We could conclude that the "ease of use" was found better than "joy of use"; however, they generally have positive emotions according to the attractiveness value.

Table 61. UEQ results for per quality aspects

Pragmatic and Hedonic Quality	
Attractiveness	1,29
Pragmatic Quality	1,30
Hedonic Quality	1,25

3.5.2.5 User Feedback

Apart from qualitative data from the questionnaire, we also asked users if they would like to give us their opinion or recommendations about the conceptual design. This part was optional and highly valuable for us to understand better their perceptions about both questions and the conceptual design. Plus, this quantitative data would support the evaluation of previous findings and provide us important feedback for refinement and future work as well.

The last open-ended question of the survey was optional. Among 136 participants, 36 of them gave feedback to us, which was 26.5% of the total amount. To enable discussion, we tagged users' feedback as "suggestion", "opinion", "both" and in the form of "positive", "negative" and "neutral". Table 62 shows the distribution of evaluation types. According to the results, participants mostly gave their opinions about the concept, the fashionable wearable, or the research idea positively. There were also neutral evaluations that participants liked some parts or features of the concept; however, they had doubts about some particular issues. Qualitative analysis of feedback was also tabled in Appendix P.

Table 62. Distribution of evaluation types and correlation with feedback types

Feedback types	**Evaluation types**							
	Positive Evaluation (+)		Neutral Evaluation (o)		Negative Evaluation (-)		Total (n)	
	F	P	F	P	F	P	F	P
	21	58.3%	10	27.7%	5	13.8%	36	100.0%
Suggestion	7		4		1		12	100.0%
Opinion	14		8		5		27	100.0%
Both suggestion and opinion	0		2		1		3	100.0%

Very few participants (13.8%) that negatively evaluated the concept design was in the form of opinion statements and only 1 suggestion came. The opinions were mostly the lack of understanding the concept, not finding novelty in the concept because smart watches can already provide these features and smart watches found more stylish than the smart half-glove. The suggestion was to enhance smart watch applications and to increase the usage. This might be seen as a negative evaluation for our conceptual product; however, smart watch

is another fashionable wearable that supports the general hypothesis of the influence of fashionable wearable. Some of the statements are listed below:

"It looks like an alternative of current wearable designs. It is still in progress and conceptual, but I wouldn't prefer to wear it as a glove." (U10)

"It is not very clear about the relation of the problem definition and the solution. I don't understand why and how this product can encourage me to walk or bike." (U19)

"There is already a huge market for smart watch technology that is compatible with phones and earphones. In this case, I don't find this bracelet beneficial and useful. It might be more efficient solution to enhance the smart watch apps and increase the usage. Besides, it is not stylish instead it is boring. I won't prefer to use it every day and it is not even close to the elegancy and ergonomics of metal chain smart watches." (U59)

"The project is just like smart watch or smart phone. I couldn't understand the novelty of it." (U98)

27.7% of participants' feedback were tagged as neutral evaluation. This form of feedback highlighted the poor style of the product, some misunderstood parts of the concept and the comparison of smart watches and the concept product that leaded users to confusion. Most of the issues stated as the appearance of the product, whether the technology would provide these features, possible high costs, could be impractical for all-day use because of fabric features. However, after every doubt and issue they stated, they ended their statements as "idea is good", "good work", "interesting", "innovative and creative", and "cool" keywords. The fabric that avoids sweating and possible internet and textile technologies that provide even more qualities for interface and ergonomics, were already explained and highlighted in videos and instructions of the questionnaire. Of course, we found normal that they focused on the prototype and basically assumed that it was the real version. Still, their general manner was found as hopeful for the conceptual design with minor changes in the wearable appearance and solving comfort issues. Some of the example statements are listed below:

"I couldn't find the relation between the fabric and internet connection/the screen. Is it 3D technology or just an image? A bit confusing and not clear. But the idea is good. If it is just for bike and walk promotion, it is too technological. Good luck!" (U7)

"I use Apple Watch and this design reminds me of it. It doesn't seem new for me. The idea is good but I am not sure about the benefits comparing to other smart watches." (U8)

"First, it is a very practical accessory. However, it evokes me masks because of the current conditions and this perception of mask cause a negative impact on me." (U30)

"I can't quite understand the difference between smart watches. All these features could be a single application that you can download to smart watches. I think the missing product is not a wearable but just a holistic application for biking or walking. Charging and battery issues would remain the same. Still, it is an interesting technology." (U31)

"The idea of designing a wearable is highly creative but I have doubts about glove. We use our hands quite often and gloves that we use in necessary cases (in cold, during sport,...) restrict most of our movement and become an extra part of our body. For short durations might be possible, but it could be tricky for long durations." (U92)

"Could be better if it has more modern style rather than bandage-looking. Users might like it more." (U101)

"Would be cool, but looks very very unrealistic. Would be a technical wonder and super expensive." (U111)

"I get the concept, and it can be more practical than the phone in a sense, but I don't know if people would like to be wearing it all the time, it would not be practical to use during work for some people, and it occupies the full hand except the fingers, it might be hot too. I think the concept is innovative and creative, I just think it does what other stuff can do." (U114)

More than half of the participants (58.3%) were evaluated the conceptual design positively. They mostly found the concept successful, innovative, creative, useful, and has potential to be better:

"Extremely successful. With the help of technology, the product can be widely used by people." (U1)

"I loved it." (U3)

"It was highly beneficial for me to use smart watch. This is a creative idea and could be a much better option than smart watch so I am curious." (U50)

"It is a really successful project and it has a potential to be improved and be so much better. I wish you a continued success." (U63)

"Great!" (U69)

"Very successful." (U94)

"I really liked it, good idea and I would like to wear it." (U95)

"It is innovative and useful design." (U96)

"Good idea." (U127)

Besides, we could clearly see from the statements that they were curious about the future concept and would like to know more about the technical and usability details:

"First things come to my mind: How could be a screen on the fabric? Is it going to be a touchable screen? How it won't be deformed? Still, it is very creative and successful." (U29)

"It is interesting but it would be great to know more about usability details. For example, which textile materials might be used, how can a product like an alternative for smart phone, make thin and implement on a glove, or others." (U38)

"Good conceptual idea. Let's see how it works and how much it costs." (U128)

There were also suggestions for the conceptual design, which we could interpret as participants interiorized the concept and came up with better solutions. Some solutions were already shared in the concept and might be missed by participants. The other ideas were related to considering motion energy for battery, fingerprint unlocking for security, heat sensitive fabric dyes, and others. Besides, some concept topics such as car warning systems and alternative transportation cards were criticized as they might not be integrated easily.

"Smart clothes that gain power from motion energy would be great." (U15)

"I think the screen surface should be plainer. Glove can get wet and might not be practical for screen when we close our hands. But the idea is really supportive and promoter. Congrats!" (U16)

"I only have doubts about the car warning system. I believe that it may not be compatible with all cars and may not be integrated with the whole system. So that it could be inefficient. Apart from that, I think the product is creative. Well done." (U17)

"It might be more interesting that it could only occupy upper hand and palm instead of whole wrist. For ventilation and avoid sweating, net fabrics might be used for the parts that have no electronics. It might also be developed from heat sensitive fabric dye for colour change. So, more improved version of this wearable can be made." (U45)

"I like the design and the idea in term of fashion. But I think the point of saying "you don't need an app" it's actually not true. The only way for this would be to have an agreement with each city that we are interested in, but that defeats the purpose in my view because it would only be useful in the cities that join the agreement, which is the problem with all the e-sharing platforms right, otherwise we would only need one app for all the cities in the world. Also in this sense, I think the device can be seen as another smartphone, only in a half glove form (which I think is pretty cool though). I think you are on the right track but need to re think the things I've mentioned above a bit. I hope you find these comments useful, keep it up!" (U102)

"It could beneficial for the security of the product to add the fingerprint unlocking option." (U108)

3.5.2.6 Section Conclusion

The final phase of this research investigated the influence of the conceptual design on users by evaluating their experience considering perspicuity, efficiency, stimulation, attractiveness, novelty and dependability of the design. These topics were highly important for us to establish a connection between a possible behaviour intervention towards sustainable mobility choices that we determined as target behaviours.

We obtained satisfactory results demonstrating that the conceptual design was evaluated positively for all user experience scales that we mentioned. Significantly, the items under

perspicuity, efficiency, stimulation and attractiveness scales were highly positively rated. The other scales were rated slightly lower than the ones listed which are novelty and dependability. Based on the UEQ scale's semantic interpretations (Schrepp, 2019; Schrepp & Thomasschewski, 2020) these findings mean that:

- Users get familiar with the concept easily, and they have the subjective impression that it is easy to understand and learn how to use the concept product.
- Users have the subjective impression that they can achieve the goals (usage of bike-sharing and walking) related to the usage of product with minimal effort.
- Users have the impression that using the product is stimulating, exciting and motivating. It is fun to deal with it and work with it.
- Users' overall impression of the conceptual design is that they like it; it looks good and enjoyable.
- Users have the impression that the conceptual design is innovative and somewhat catches their attention.
- Users have the subjective impression that the conceptual design is somewhat dependable and they fairly feel that they completely control the interaction of the product.

Additional to these findings, feedback from users apart from the UEQ scale also demonstrated the positive opinions as well as the potential of the concept considering the catching attention, suggestions for improvement and other excited and curious statements.

The conceptual design was located in the future smart concept with future technology requirements. Fashionable wearable, which was in the form of smart half-glove, was the key element of the concept. Concept development was accomplished considering strategies of design for behaviour change to contribute sustainability. Taken together, these results suggested that the conceptual design had a positive influence on users, which is a significant stimulus for behaviour intervention.

3.5.3 Overview of Fey Findings

Key findings from Phase Five are demonstrated in the following Table 63.

Table 63. Results and outcomes of Phase Five

User Experience Analysis Results/Outcomes:
1. The majority of UEQ scale items were evaluated positively (25 positive evaluation 1 neutral evaluation). There were no items rated negatively. **2.** Highly rated items were suggested that conceptual design is very (1) innovative, (2) supportive, (3) understandable, (4) good. **3.** Other considerably rated items identifies the conceptual design is fairly (1) practical, (2) clear, (3) organised, (4) easy to learn, (5) valuable, (6) interesting. **4.** The overall user experience scales were evaluated positively. From highest to lowest: • Perspicuity • Efficiency • Stimulation • Attractiveness • Novelty • Dependability **5.** Highly rated scale was perspicuity which means that users found the conceptual design easy to use and learn. **6.** The impression of users concerning the pragmatic quality was slightly higher than the hedonic quality.

In this phase, we conducted a user experience questionnaire with additional survey questions that target comprehensive evaluation of the conceptual design. Results from the questionnaire provided us to realize the perception of users, the need for refinement of the concept solutions and the power and the influence of the concept on users.

The results were found satisfactory considering the scale means, which suggests that the impression of users concerning both pragmatic and hedonic quality of conceptual design was positively evaluated. Furthermore, the overall attractiveness of conceptual design was also rated positively based on scale values. We could conclude that the design of fashionable wearable which was the key element of the concept is found easy to use and learn, is able to achieve the goals established, stimulating, exciting and motivating. Furthermore, it looks good, enjoyable and innovative. All these qualities were found meaningful for the motivation of target behaviour change that would be discussed further in the Conclusion Chapter.

CONCLUSION

In conclusion, we bring together the overall findings of the research and discuss the implications of the findings for the field through revising the research questions. The limitation of the research data and further research suggestions are also explained.

Answering the research questions

This study proposed one main research question and five secondary research questions. To better understand the research findings, the research questions are examined in the following.

- *Which are the behaviours in the city life that more negatively impact sustainability?*

We tried to seek the answer both in expert interviews and literature review. According to expert interviews (see Table 14) that we conducted, "overconsumption" or equivalent statements that imply that action was pointed out as the major negative impacts of everyday life. Consuming more than we need in clothing, energy, and food was also emphasized. Even though city life was found more efficient than living in other locations concerning sustainability, the scale of cities was also pointed out as an important issue (see Table 15). As cities are scaling up, more resources such as food to feed people, energy to be used in the houses in the form of electricity or water are needed, and more carbon print occurs because of the transportation of resources. Additionally, the examples of sustainable behaviours suggested by the experts were, in this order of importance, "consume less", "to be aware", "try to be informed", "use bike or bike-sharing", "using public transportation", "walking", and others (see Table 21). Most of the topics fall under the umbrella of mobility, which appears to be a common concern in city life.

According to the literature review, key domains of everyday life were suggested from three different resources (see Table 16), which can cause important negative impacts in urban life. The topics identified were: food or eating, what we eat, how it is produced, provided or disposed of; housekeeping, how we live, how we heat or cool the house and other habits in the house; consuming goods, how we buy or use them; leisure time, how we entertain or socialize; and mobility, how we move around, how often we travel and which type of mobility we choose. Globally, people's behaviour on all these topics generates negative impacts on city life. However, "mobility" is one of the main critical factors of cities and an

important component of urban metabolism (see section 1.2.3) as cities' main objective is to provide "access" to all necessities of life. Additionally, many approaches to ensure sustainable and smart cities emphasises improving mobility as a way to reduce congestion and pollution, to improve air quality, to reduce smaller urban footprint, to increase people's safety and many other sustainable outcomes (see section 1.2.3.1). To conclude, considering the findings obtained, it can be seen that mobility behaviours have the most negative impact in city life.

- *Which are the main obstacles that prevent users from adopting more sustainable behaviours?*

Through expert interviews, we identified five topics that act as obstacles to the adoption of sustainable behaviour (see section 3.1.2.1.4). (1) People perceive sustainable products as more expensive, although this is not true in all cases; (2) People are not interested in the topic. As they cannot always see the direct impact this issue has on themselves, they tend to disregard it. Moreover, unsustainable actions are more easily found by people; (3) People are not aware of the true negative impact of their habits or actions. As they are not well informed, it becomes more difficult to make conscious choices; (4) People's false perceptions, together with unreliable information cause misguidance; (5) Complexity and comprehensive characteristic of sustainability are hard to deal with by people.

The literature review corroborates experts' arguments with human behaviour theories, design for behaviour change, and design for sustainable behaviour strategies (see sections 1.1.1, 1.1.2, 1.1.3). The most mentioned factor is the "need for motivation". People think in two different cognitive systems of reasoning, conscious and unconscious. In short, they do not always decide rationally, which means that just knowing the fact and knowing what the "ideal behaviour" is does not necessarily mean that they can easily adopt it. They need motivation, they need to see the benefit of that decision. The target action should feed their physiological and psychological needs and values. To conclude, the main obstacle lies in the scope of understanding human behaviour and psychology. Another obstacle is the complexity of the sustainability concept, which causes misinterpretations and/or misunderstandings, resulting in a lack of knowledge about the impact of the everyday choices.

- *Which are the purposes of fashionable wearables inside a strategy for behaviour change?*

Fashionable wearables are designed garments or accessories that combine aesthetics, style and technology (see section 1.3). The fashionable wearable term emphasises two pillars: “smart” technology and fashion.

The “smartness” of a product is related to the digital properties that it has, consisting of sensors, processors and actuators to collect and transfer data. “Smart” products in the wearable industry offer many successful features for different contexts, including entertainment, fitness and wellness, military and industrial, healthcare and medical (see Table 7). These wearables offer non-traditional functions compared to regular clothing or accessory offers. As literature enlightens, they can communicate, transform, conduct energy, and even grow (see Table 8). Additionally, IoT technology plays a key role in enhancing the functionality of wearables and other products and even transforming the urban environment around us. The future is built on these advanced technologies that are being used as a solution for many demands and problems (see Figure 21).

The other pillar fashion, basically aims to add the meaning of aesthetic, emotion, human-oriented and identity to the wearable (see section 1.3.3). Constructing identity and showing a social status or participation of a community addresses the complex emotional needs of users. Fashion term, as we used in relation to “clothing”, also provides physical and functional body-related benefits, making it practical. No other products have a strong relation to the human body and identify the personality at a single glance than fashion products in the form of clothing and accessories.

Besides literature, expert interviews also gave us significant purposes for behaviour change (see sections 3.1.2.1.5 and 3.1.2.1.7). Most experts definitely agreed on the power of fashion to overcome the obstacles to sustainable behaviour, emphasizing the power of “being part of something”, “presenting yourself”, “having an identity”. They mentioned health-related wearables that are currently being used and their benefits as they are making life easier and are more engaging or motivating.

In the conceptual design phase, we explored the relationship of fashion to conceptual design solutions for behaviour change (see section 3.3.4.2). Some of the ideas obtained, presented next, summarise well the main findings for this research question: People are not rational in their decisions, otherwise, we will not be consuming so many products today. The fashionable wearable can be a symbol of identity, which may have a semantic meaning (see Table 37). Clothing is expected to be “smart” in the future, and to increase data sharing (see Table 38).

In summary, our findings suggest that technology and fashion contain great potential for motivation. “Smart” products are already in today’s daily life and are expected to be the core characteristic of future products, including clothing and others. These provide solutions that can not only increase the quality of product, make it easy to use, but also extend the functionalities and possibilities embedded in fabrics. Fashion feeds the emotional and body-related functional needs of human being. Thus, combining all these characteristics, we are of the opinion that fashionable wearables are able to overcome the obstacles to sustainable behaviour and provide motivation, usability, functionality as behaviour change strategies.

- *Which properties should fashionable wearables have, to be well succeeded for this purpose?*

The fashionable wearable is a “smart” product that requires design considerations for construction (see Table 29); e.g., (1) body ergonomics, the placement on human body, sizing, attachments and wearability of the product; (2) perception of users, if it is aesthetical, psychological or emotional functions perceived by users; (3) functionality, usable interaction system, modularity; (4) technology, embedded systems, sensor, IoT or other enhanced technologies; (5) materials, electronic textiles, the feature of smart textiles; (6) energy solutions, batteries, solar or kinetic energy; (7) recycling, ecological or biodegradable materials. These are also guidelines for designing fashionable wearables. Therefore, fashionable wearables need to satisfy these factors to be successful designs for changing behaviours.

Another critical requirement is to follow design for behaviour change and sustainable behaviour strategies. In the literature review, we can find many strategies to deal with these two concerns (see section 1.1.3). Based on Daae and Boks’ (2017) approach, strategies are (1) increasing the motivation of the user, (2) persuading the user to behave in a desirable way, (3) making the undesirable behaviour difficult or requiring extra effort, (4) enabling the user to behave the desired way, (5) threatening with consequences if they do not behave as desired, (6) making the desired behaviour easier than the alternatives, (7) providing feedback about how to behave the desired way, (8) helping the user create goals for desired behaviour, (9) guiding user or make the desired behaviour intuitive, (10) disabling undesired functions, (11) providing information about how to behave the desired way, (12) rewarding users who behave the desired way, (13) forcing users to behave the desired way, (14) reminding users what to

do if they have forgotten, (15) punishing or making the experience of undesired behaviour negative, (16) making the desired behaviour happen automatically.

Fashionable wearables should have properties that satisfy at least some of these strategies to be successful in a behavioural intervention. However, there is no significant evidence of which is the most appropriate strategy to apply, as they are all useful for certain situations and for certain products, which designers can decide which to choose (Daae & Boks, 2017). We chose strategies Number 1, 2, 3, 6, 7, 9, 14 and 15 for the smart half-glove that we designed.

Besides these requirements, we also think that solving the problems pointed out by the users will be another success factor for these products. In our case, the problematic topics on mobility choices were related to personal excuses, digital app issues, changing weather conditions, lack of information provided by the system, lack of facilities that target mobility modes have, lack of sustainable options by default, requiring additional preparation before using the target mobility modes, confusing systems, insecure/unsafe conditions. These problems were highlighted to be solved by the specific smart fashion product. Users' problems have to be overcome depending on the target behaviour(s) and product or system. To conclude, the properties of fashionable wearables require design considerations, satisfying behaviour change strategies, and solving users' problems.

- *How can we assess the impact of fashionable wearables as actors for behaviour change?*

According to Fogg's (2009) Behaviour Model, the relationship of motivation and ability with an effective prompt cause behaviour change (see Figure 7). Ability is directly proportional to the simplicity of the product/system, requiring a bit of physical effort, time and money. Motivation is related to the sensation of the user, if the product cause pleasure or pain; the anticipation of the user in the form of hope or fear, and the belonging of the user considering social acceptance or rejection. Finally, a prompt can be a cue, a trigger or a request. This model suggests that if the user has sufficient motivation and ability with an effective prompt, behaviour change can easily occur. Variables: "motivation" and "ability" do not necessarily need to be on the highest level at the same time. In a sense, either of them can be above the threshold level to cause the intervention. Even though the sufficient amount is not clearly stated, possible behaviour change can be interpreted by the user's level of motivation or interest and the simplicity or usability of the product.

Previous studies made assessments for behaviour changes with different methods. Evaluation of designed concepts, Processes of Change Questionnaires that are basically asking users to rate their opinions about the pre-determined statements with 5-point scales were used (e.g., Ludden & de Ruijter, 2016). Semi-structured interviews that measure users' perceptions and feelings about the design, were conducted (e.g., Lidman & Renström, 2011). Direct questions were asked before and after the use of prototypes, such as "Would you use it?", "How was the experience?", "Has it changed any behaviour in your life?", "How do you feel when you use it?" depending on the prototype of the products. Some researchers made focus groups to understand the potential and effectiveness of the design and gain insight into how users interpret the proposed design and conducted 5-point scale questions for attitudes and behaviours (e.g., Thieme, et al., 2012). Cash, Hartlev and Durazo (2017) state that practical assessment should focus on the feasibility of the intervention in terms of time, resources, effect, and scalability. Besides, the overall efficacy should be related to the behavioural requirements specification to ensure overall alignment with the wider strategy.

As seen in the literature, the main strategy is to follow the behaviour change strategies and decide the one or combinations for the target sustainable behaviour. After, research methods such as questionnaires, focus groups or interviews to understand the perception of users, to evaluate the design in terms of usability, aesthetics, functionality, and other aspects can be applied. In our case, assessment of the impact was measured with the UEQ, which is one of the most recognized questionnaires that collects opinions of users regarding thepragmatic and hedonic characteristics of a product (see section 3.5.1).

- *Can the use of fashionable wearables promote sustainable behaviours as part of a strategy for behaviour change in smart city context?*

This question is the main research question of this research. Starting from the knowledge expansion at the beginning of the research, we sought an answer to this question. We discussed with experts from the sustainability field (see section 3.1.2.1.7 and 3.1.2.1.8) about the potential of fashionable wearables as a strategy for promoting sustainable behaviour and the research question which is in the context of smart cities. The literature review also supported the potential of fashionable wearables considering technological advancements, fashion notion, future trends and others as we mentioned in previous secondary research questions. In the light of such findings from the literature and experts, we designed a future concept with the key element of the fashionable wearable (see section 3.3). Concept

objectives were created based on Design for Behaviour Change (Daae & Broks, 2017) strategies to solve user problems with certain design considerations (see Table 32). The objectives were: (1) Providing options to different genders and body proportions, (2) providing options to different fashion tastes, (3) providing guidance and motivation for mobility system, (4) making aware of the user for the actions taken before, (5) creating goals in daily life routine, (6) providing a reward for desirable action, (7) providing an alternative option for mobile phone, (8) providing a solution for battery issues, (9) providing an alternative for transportation card, and (10) providing security for possible danger. Concept ideas and solutions were evaluated as being satisfactory enough to reach these mentioned objectives. No item or objective was negatively evaluated (see Table 36). Benefiting from the results, we made minor alterations in the fashionable wearable concept (see Table 47) and finalized it with an additional prototyping phase (see section 3.4). We conducted a user experience (UX) questionnaire to evaluate attractiveness, perspicuity, efficiency, dependability, stimulation and novelty of the conceptual design. Based on the results, we can consider that the conceptual design was positively evaluated on all user experience scales. Significantly, perspicuity, efficiency, stimulation and attractiveness scales were highly positively rated (see section 3.5.2.4). The UX assessments resulted in the following findings: (1) Users get familiar with the concept easily, and they have the subjective impression that it is easy to understand and learn how to use the concept product, (2) Users have the subjective impression that they can achieve the goals (usage of bike-sharing and walking) related to the usage of the product with minimal effort, (3) Users have the impression that using the product is stimulating, exciting and motivating. It is fun to deal with it and work with it, (4) Users' overall impression of the conceptual design is that like it, it looks good and enjoyable, (5) Users have the impression that the conceptual design is innovative and somewhat catches the attention, (6) Users have the subjective impression of that the conceptual design is somewhat dependable, and they fairly feel that they completely control the interaction of the product. In addition to these, users' feedback also mostly showed the positive opinions as well as the potential of the concept considering the catching attention, suggestions for improvement and other excited and curious statements (see section 3.5.2.5). In the light of the user experience evaluation, we believe that this fashionable wearable concept will have a positive influence on users, representing a significant stimulus for behavioural intervention. Based on these findings, we are of the opinion that fashionable wearables can promote sustainable behaviours as a part of a strategy for behaviour change.

Limitations

Some limitations of the overall research process should be taken into consideration when generalising these results. This section reflects the main limitations and give guidance for future research.

- Expert interviews (in Phase One), focus group sessions (in Phase Two) and expert evaluation sessions (in Phase Three) for conceptual design are necessarily limited by the specifics of their contexts, such as the skills, interests, backgrounds of the participants as users and experts. The nature of all sessions is pre-planned and semi-structured, which means that idea or problem generation is somehow restricted in the context and the researcher.
- The articles and other publications included in the systematic literature review analysis for mapping sustainable behaviours (in Phase One) are restricted to limited databases. Additionally, the keywords used in the search for publications, the framework used to formulate sustainable behaviours through the lens of everyday life are also limited. The possibility of deepening the analysis and diversifying the databases/keywords should be highlighted.
- The context of the study is future smart cities; therefore, scenarios as well as conceptual design environment were created based on this context. Designing a concept for the near future clearly creates several difficulties. First, the future can always provide unexpected technologies far beyond our imagination and consideration. However, starting from 1948, the concept of future analysis studies has been developing verified methods of scenario building, computer simulations, technological forecasting, the Delphi technique and systems analysis (Bell, 1996; Somerville, 1999). The future environment, technological advancements and possible features of the concept system is designed with respect to trend analysis reports, trend research, consultant company reports and envisioning future reports in the field of smart city, smart mobility, wearables, textile technology and IoT technology which are used these future envisioning techniques and methods (presented in the Literature Review Chapter). Designing a future concept based on these studies can limit the ability to generate ideas on the concept. However, we tried to overcome these constrain with ideation sessions with expert evaluation of the conceptual design. Secondly, the production of future concept product with embedded technology was

not possible for us in the current technological possibilities and limited time frame. Therefore, in the user experience questionnaire, respondents are only able to assess the conceptual design according to their perceptions by watching two short videos that demonstrate the problem environment of the concept and solutions of the concept with additional prototypes showing the features and some of the functions of the fashionable wearable with computer simulations. The perception of users is only based on the prototyping technique of Wizard of Oz (explained in section 3.4.1 and 3.4.3). An experimental study including wear testing of mock-ups that allows users to put on, touch and feel the physical product might provide valuable feedback to draw conclusions for ergonomics. However, this might also provide drawbacks because mock-ups that are not having adequate future technology might misguide users.

- The absence of an industrial collaborator caused another limitation for this research. The involvement of such a partner could provide us funding contribution, expertise and potentially better prototyping capabilities. Although we were able to clarify and visualise the concept idea with other validated prototyping techniques, with an industrial partner we could have more, real-like tangible mock-ups, which could increase credibility in what regards the effect on changing behaviour.
- The study is restricted to the target sustainable behaviours selected based on the Literature Review and particular findings and outcomes from Phase One and Phase Two. The possible intervention of behaviours is limited to the mobility choices of bike-sharing and walking in everyday life.
- The fashionable wearable, which is assumed to be a potential of motivation tool for sustainable intervention is also restricted as smart half-glove. Therefore, the key concept of smart product represents fashionable wearable cases. The study is limited in its concept development in terms of the relevant design characteristics of fashionable wearables and the selected design for behaviour change strategies.
- The general intention of the study is to promote sustainability by reducing negative impacts on everyday life caused by human behaviour. Ironically, reducing societal impacts by designing a fashionable wearable would in fact increase the use of materials and induce consumption of a smart product. However, we tried to emphasize the system and solutions of the conceptual design with ideation sessions with experts rather than simply designing a single product. We know that it also provides a great benefit by reducing carbon emissions and achieving climate neutrality, implementing

healthy behaviour by avoiding sedentary everyday life, which are all important contributions.

- The smart city concept is still evolving and comprehensive. Our conceptual design is framed in a smart city in the near future, which requires to fulfill characteristics and factors of the smart city concept of Giffinger, et al.'s (2007). This clearly creates several limitations for the content of the conceptual design.
- Inevitably, there are many other methods and analysing techniques to provide the objectives of each phase that we did not choose, within the constraints of time, finances and the requirements of the doctoral research. We conclude the research with the findings of user evaluation, perception and feedback on the conceptual design prototype, which provide a strong basis for the possibility of behaviour change. It is only fair to say that any kind of change is extremely difficult to accomplish. It depends on several variables including willingness, culture, environment, education, ability and many others. However, targeting design interventions to people's motivational state and how ready and willing to change people really are, seems like a logical approach (Ludden & de Ruijter, 2016). Behaviour change strategies were used in the design phase; briefly, the motivational state and usability of the concept product were examined as behaviour change drivers. All in all, the measurement of behaviour change is provided indirectly which is another limitation of the research that must be highlighted.

Contribution to Knowledge

This study's contribution to knowledge in the design discipline takes place in a systematic research enquiry into promoting more sustainable behaviour through the concept of fashionable wearable design. Our literature review showed that other investigations aiming to change or influence behaviour through the design of a product, mainly focused on the theoretical and practical dimensions for designers with an outcome of frameworks or toolkits. The others which practised the strategies from the toolkits, focused on reducing the negative impact of the product itself when in interaction with the user. For example, designing a bin for changing behaviours in littering, recycling or other end-of-life related actions. Another example might be given as designing a kettle for changing water or energy consumption related behaviours. The product and the behaviours were connected to each other. In our study, the product is the concept of fashionable wearable, which is not primarily focused on a

product but the system around the smart product. This research is novel as it aims to involve designers, researchers and engineers in the idea generation process, and additional user perspective in the evaluation process of the design concepts to think the system globally not just to design a product. Furthermore, the research combines segmented fields of fashion design, computer engineering, technology studies, human behaviour, future studies, sustainable design and others. It is not common to join these areas of knowledge in an attempt to solve a global and wicked problem like this. Therefore, this research contributed to knowledge by bringing various disciplines together to focus on the system globally for behaviour change.

The major contribution of this research is the process of itself. The answers to the research questions which we examined previously also demonstrate the contribution to knowledge in design practice and design research. Synthesising and organising strategies derived from previous studies, conceptual design development, evaluations of experts and users with the insights arising from each stage of the five phases provides an original contribution. The outcomes from each phase can help designers and researchers with a range of interests, from UX to engineering, and influence other concepts to solve other problems in both current cities and future cities via their own practice.

Ultimately, this research started with the main critical question: “Can the use of fashionable wearables promote sustainable behaviours as part of a strategy for behaviour change in smart city context?” Our main motivation was to explore the potentiality of fashion and technology, and according to a socio-critical perspective, we assumed that fashionable wearables were able to encourage more sustainable behaviours in future cities. Coming to end of this study, we were able to confirm our hypothesis, applied our insights to build knowledge in design field and produced documentary evidence of the research, linked the theories and approaches in diverse disciplinary fields.

Recommendations

This research has contributed to the field of Fashionable Wearables, Sustainability and Design for Behaviour Change. We were able to prove that fashionable wearables can have an essential role in promoting sustainable futures in everyday life, considering the limitations we discussed in the previous section. Without the constraints of time, many other directions could have been taken. Providing guidance from the limitations, the research should be seen as a

starting point for future work. Some recommendations for future work are proposed in the following.

- The most obvious area for future development is to prototype the concepts for multiple fashionable wearable options with industrial collaborators in detail to test prototypes with users in a real use environment. It would offer tangible results of the functionality and ergonomics of the product. It would also provide multiple testing and ideation sessions for better refinement of the conceptual design.
- It appears that designing for behaviour change provides an opportunity for design innovation and sustainability. The literature demonstrated several promising behaviour change strategies used for influence more sustainable actions. It is advisable to combine different design strategies to address different user problems and demands in different concepts with the same artefact. We mapped various sustainable behaviours in different everyday life domains that are waiting to be focused on.
- The development of the fashionable wearable concept to promote target behaviours was based on one design case, which was smart half-glove. To consolidate and expand achievements, further work could take the findings from previous phases and apply them for designing other types of fashionable wearables. There is a wider range of fashionable wearables based on the location of the human body that may have equal or higher potential.

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APPENDICES

A. Expert Interview Transcript

Date: 21.02.2019
Place: IADE-Universidade Europeia
Expert 01

Could you briefly tell me about your professional career, projects that you participated/ coordinated related to sustainability?

I am an industrial designer from IADE. I finished my initial studies at 1999. After, I went to a company in the north of Portugal to an internship and then after around one year I came to Lisbon again. I started in the institution called INETIC. It was a national laboratory of research. Nowadays the name is LNEG – National Laboratory of Energy and Geology and since 2009 I started to work in the topics of eco-design, then change my focus into design for sustainability. Nowadays, I am engaged in circular economy projects. I participated in many projects related with these fields and other such as value analysis for sustainability, energy efficiency... Nowadays I have two projects on circular economy.

It sounds like you are quite busy! Let us start with the definitions. There are many examples of diverse definitions of sustainability and one of the most well-known definition is in Bruntland's report as you know; it explains it as development that meeting the need of present without compromising the ability of future generations to meet their own needs. Others like balance between 3 pillars: environmental, social, economic... Could you define sustainability with your own words? And what does sustainability mean to you?

Sustainability for me, to use correctly the link between 3 pillars: environment, social and economic part. Without one of the pillars, you can't achieve sustainability. Of course, we have to be active and save the planet, avoid pollution and so forth... But we need to have economic benefits. Because without economic benefit, we don't have companies, we don't have wealth that we need. And social part is of course very important which is sometimes forgotten. For me, a sustainable product or sustainable service has to be a mixture of those 3 pillars.

General Assembly announced 17 goals and 169 targets to stimulate the action in the concept sustainability including topics such as zero hunger, well-being...

Are we talking about sustainable development goals?

Yes. So the topics are zero hunger, well-being, gender equality, education quality, climate actions and so forth. But more recently the approaches are focusing on cleaner production, waste management, social responsibility, eco-design, recycling among many other terms. Based on your experience, do you think we (I mean companies or researchers) are disregarding some of the responsibilities of sustainability? Are all the pillars of the concept equally concerned together or equally?

No. For example you said cleaner production. For me, it is a very old concept. When you go to the history, in the 70s we started to be aware of the environmental problems and for that Papanek is a well-known writer. He was very important because he gave the role of design has a big importance in this sustainability aspect. And then, in the 70s, companies started to understand the problems for environment. They came up with end-of-life solutions. But what they were doing was to solve the problem in the end of production. They had waste; they made some facilities to take care of the waste. They had emissions, they put some filters and so on. It was the end of the pipe, and that solution was not good. They were consuming resources, consuming a lot of money and trying to solve the problems. So the next step was cleaner production. In Portugal, the institute where I work, were the pioneers in cleaner production in Portuguese companies. And they start in 80s. So, and the idea was to look at the production and make the production more efficient. And then the next step was eco-design. Because, the cleaner production is not enough. Of course, in any process in any project, you should have some cleaner production measures. You have to think about the company and you have to try to optimize process. But you have to have an holistic approach. Not just process that you have to work on the product, and lifecycle.

Ok, can we say that there was a tendency of environmental pillar was more concerned and the other social parts are less concerned?

Yes, yes. And for me that was the problem. Because everyone talks about sustainability nowadays. And for a lot of people, sustainability is like a bad word because everyone talks about it. A lot of people don't believe in sustainability. It seemed as a flag for niche market, it didn't work as we expected. Now, in circular economy, we are trying to solve the problems that we are not able to solve with sustainability development.

So, can we say that sustainability is an old-fashioned word or definition now?

Well, (hesitate) Yes and no. Yes, it is an old-fashioned word and is being used in everywhere and the meaning is not what we want. Because people are using the word for everything so we are loosing the meaning. Now, we need to be clever and be clearer about the definition and we need to demonstrate the benefits. Not just for the environment but for the society and for the economy.

In your opinion, what are the main difficulties or obstacles of sustainability?

For me, most of the professionals that are working in sustainability field are not able to demonstrate the benefits of the application in the context. From my experience, I have been working in a lot of project, in all our projects the idea is to evolve companies. It is really difficult to engage companies because they don't see the benefits.

Do you think if there is a benefit for companies?

Yes, I believe that. But the benefits sometimes… Their time frame for seeing the benefits is very short. And we can see the benefits only applied methodologies in companies. But there are some options that long term there are some benefits that are indirect. We need to have a clear picture and make an assessment.

Let us go to the behaviour side. How can a behaviour be considered as sustainable? If it can be considered? What does sustainable behaviour mean?

You have four types of consumers. This is in my paper for one of my unpublished paper. You have a lot of niche markets. You have sustainable products; sustainable behaviours are seen and are more available in niche markets. Because usually, and that is not true but usually, sustainable products are more expensive. And the consumer believes that just for being more sustainable is more expensive. Also, there is a gap between what consumers do and what consumers say. If you ask a hundred people if they are aware of sustainability problems in our world, if they are willing to pay a bit more to buy a sustainable product, if they have a sustainable behaviour, all will say yes. They all want to buy sustainable products and they are able to pay more. They say that but they don't do that. They are aware of that but they don't apply. For example, there is this study on Dutch consumers. Dutch people are seen as one of the societies that has more environmental awareness and concern. The paper is really interesting. They talk about they all say that they are sustainable, behave like that, but that is not translated in actual sales of sustainable products. The reason for them to be sustainable is very strange because what they realize in that study is that they are more sustainable to show the others. It is not real concern about environment about buying healthier products, it is just to show-off to neighbours that they are buying sustainable products and so on. And this is the reality in everywhere.

You talked about 4 types of products…

Yes. One is the products that are "naturally sustainable". Their materials or their production processes are sustainable. And other products are what I call "silent product" that were developed with sustainable concerns but they don't show it to users. A lot of examples are in packages and cars… There are products that are developed with sustainability methodologies and they are sold as eco or sustainable. And there are other products that are "not sustainable itself but they promote sustainable behaviour". For example, separation waste bin that made of plastic is not sustainable because the material is plastic. However, it is promoting sustainable behaviour.

Could you give me some examples what could be sustainable behaviours?

Sustainable behaviour is to look at the products and have a notion of their lifecycle. It is the optimal situation because there are other behaviours that people don't waste a water or energy at home, make separation at home. Ok, this is valid of course. But majority of people that have some sustainable concerns that consume less resources, less energy less water, recycle materials at home, so this is the majority of sustainable behaviour. And then I think that people nowadays are more aware of our problems and we have more sustainable products available. But I think that sometimes there is also some kind of mistakes in the perception of users. Sometimes people think that they have a sustainable behaviour. In fact, their behaviour is not so sustainable. And then you have another thing is important to consider. When you have more sustainable behaviour in some cases, the overall consumption is higher. For example, imagine a home with normal lamps and they consume x amount of energy, they want to be more sustainable and they changed to LAD light. So, the consumption ideally will reduce a lot. But in practice, in most of the cases that doesn't happen because they have the notion that since they are using LAD light,

they can have the lights on much more time. For example, you see lots of these in Denmark. Denmark is the country where you have all the solutions, all the examples of the sustainability, circular economy, eco-design. They are very good on that. Since they are so proud of the achievements on sustainability, and they are country with high economic power, they consume much more. The overall benefit is not so much.

Buying sustainable products are not making us behaving in a sustainable way?

Depends of course. The problem is when you change the consumption habits, you buy sustainable products. But if you use more often the product, the sustainable benefits sometimes are not visible.

If we restrict these examples of sustainable behaviour in the context of city life or being a citizen, can you give some other examples?

Nowadays in the city you have a lot of scooters. That is good in the way that you have electric mobility available all over the city but what in the end happens is that some of the people that are using was walking before. They were doing exercise, and they were not wasting energy because they are electric and the consumption is something. So, you are not solving the problem. We are trying to solve the problem, give more possibilities for users but we have some drawbacks.

What might be the major unsustainable impacts of people's everyday life?

Overconsumption. We buy more than we need. If we go for example to fashion. Everyone has a lot of clothes at home that they don't use. And we buy clothes every year. And in some cases, clothes are so cheap that you just buy them. In terms of energy at home. Nowadays you have a lot of appliances for everything. For example, if we compare the kids with the kids 20 years ago. Nowadays they stay at home, on computer, telephones, tablets and so on. They consume a lot more energy. Transport also. Food waste.

Do you think city life has additional impacts of people's everyday life by opposition of living other locations like suburbs, mountains?

No. For example I don't live in the city. My daily energy consumption is huge. Because I come to city everyday by car. I need car to go shopping. If I don't have potatoes at home, I need to use my car to get just potatoes. In city, you don't need that. We have everything closer and you spend less energy because of transport. And another thing, in the city, houses are smaller than outside. And outside you have larger houses that consume more energy more materials also.

In your opinion, what are the main reasons of people to adopt unsustainable way of behaving? What might be their reasonable excuses or reasons to behave like that?

I think that our society is not sustainable at all. Our nature is not to be sustainable. The change is in being sustainable.

Do you think we were not sustainable before? Think about your childhood for instance.

Yes, it was more sustainable because we had less access to things. For example, if you compare our society with India. The waste production of average person in India is much more less than ours. So, we can say that they are more sustainable than us. But why? Because they don't have money to buy things. And they have to reuse everything they have. They don't do that to be sustainable, they do that from an economic point of view. If people don't have money to buy stuff, they don't consume, they don't produce waste. But consider that people have more money, they will consume more, they will buy more. Money is the trigger.

Considering these reasons or obstacles for sustainable behaviour, to what extend do you think fashion can overcome?

Yes, I think it can overcome. When you look at the fashion industry that consume more. The production has high impacts, the overall consumption of the materials is huge. And the behaviour of people concerning fashion is to consume and consume. We don't buy clothes to live, but to show. The overall consumption is way more than our needs.

Do you think technology can overcome these obstacles? Can it change the behaviour?

Maybe, yes. I think so. The problem with fashion is that everyone wants to be different. And everyone wants to look different everyday. Everyone wants to show new clothes, new ways to dress. For example, the clothes that you sell this year are different the clothes that will be sold next year. You have this notion of the latest edition of clothes and new arrivals. With technology, you can focus on the changes, the adaptability, the customization. So, you can in a way reduce the consumption of resources by focusing on technology. Maybe, yes. Can be a way.

Do you think fashionable wearables, smart clothes, smart accessories can overcome these obstacles? Can they guide them to change the behaviour?

Yes. It might be expensive. But it depends on the solutions. Let's imagine you develop a special wearable that can change the color everyday, or can change the look, texture, yes it will be more expensive. But in the end, you don't buy other products. Maybe. You have huge straight-offs. You have to think on the benefits and what might change.

We are coming to end. This question is directly related with my research. What kind of sustainable behaviours can be promoted with fashionable wearables? Also, you can think in the concept of smart cities, internet of things…

Hard question. It depends on the level of technology but you can. For example, if you develop 3D process to print your fashion artifacts at home, it can be an innovation. You can reduce production in other countries and avoid a lot of transport. Then, it will be so easy for people to have new products everyday, they will consume more. They will produce more. So, you have to have a balance between the technological solutions and the consumption. Of course, you can have a technology in clothes to minimize wash, you can have technical materials that have some self-cleaning properties that you don't need to wash. But if you have these kinds of products, you have to make sure that people will change behaviour. It is a tricky question.

Considering everything we talked today, do you have any suggestions, advise or any traps I should avoid coming to your mind related with this research?

I think the most difficult thing in sustainability is to change behaviours. We have 2 options. One is force people to change, and that it is not working, or you can think about ways to add value for the users. If you add value in the direction of turn them in a more sustainable way, it will work. If you want to change consumer, you need to make sure that they benefit with it. By themselves, they don't change, if it will be harder for them, if they will need to change without knowing why or without having clear benefits, it won't work.

Do you think we can raise awareness by technology, do you think they can change if they know if something is unsustainable, impact or harm? Knowledge can affect them?

No. I think nowadays everybody is aware of it. You can compare that with cigarettes. Everyone knows that cigarettes are bad for your health. They keep on smoking. Everyone that smokes knows that is not good for the health. And sustainability is the same. Everyone knows that we have problems in our resources, we don't have enough resources to feed the world, pollution is a problem. Everyone knows.

Even if they don't care about their health, why they would care about future generations?

Yes.

Should I quit? Should we quit?

No.

Then what is your motivation to keep on trying to find solutions? This means that you are thinking that you can find solutions. But you don't want to work with people?

No. we have to show the benefits. When you work with companies, when you want to implement sustainability measures in companies, the aim should be the benefits for the company and for the workers and of course for society.

Date: 28.02.2019
Place: IADE-Universidade Europeia
Expert 02

Let us start with you. Could you briefly tell me about your professional career, projects that you participated/coordinated related to sustainability?

My background is an industrial designer that focuses on sustainability. Basically, it started to permeate on the work through a professor that was very into that topic. I think it was just a natural evolution of when one tries to do a better design project, regardless of the area of expertise. In my case, an industrial designer went towards lighting design and when you think about lighting design, you have several points where you can approach the sustainable part of it. And this a bit even saying part of it, not a part of it. A good design project should be sustainable in itself so something good is not an addon but is embedded. In the case of design, of course the most obvious part is energy part, talking about resources. But for me even the most interesting part is the people part so the social aspect of it. How you can use lighting to be basically better people's wants. So, it started to go from there in terms of project, professional project I worked with colleagues so it is the professional level. We

tried to design solutions, try to design lighting that respects what I mentioned, consume as less as possible and enhance people's light experience as best as we can within all constrains as budgets and timing and so on. But it is embedded in the idea of doing projects so that's in the form of professional level. From an academic level, I would say that still starting in an early career as a researcher so PhD is definitely the biggest part of it. It was on the same align so the idea was also approaching through lighting design, in this case, public lighting design. And again, pointing the same topic where you have a relationship between the sustainability related to energy consumption and behaviour. By associating what we consider to be well-being in a general term, the idea was that you only have well-being when you have a balance relation between resource (energy consumption) and the perceived well-being of the end-user. So, the idea was how we could use that technology to enhance the adaptability of the lighting solution, force a better behaviour and of course it was related with the lower consumption. We tried to understand how we can find the balance between what people want and what it demands from the resources part. So yes, that was still the biggest part of my research. Currently, try to develop this approach of course one of the end goals of the PhD research was to produce its methodology so it is something that you can apply in different context (of course always talking about lighting) and to see if the results that we have are similar or different how they diverge. The idea is to replicate, my interest was to replicate the experiment. From another point, I would like to virtualize, try to apply this methodology in a VR context or at least digital context. Because the problem of lighting is, it is a human experience, so you should do it with real equipment and in a real context with real people. In that along demands resources normally expensive resources so the idea for replication is way harder when you do it physically. Of course, we are doing in virtual scenarios. My idea is trying to basically for one replicate and for other, to see if I can approach as best as possible the experience that I have from the PhD. I have a case study that I can use it as an anchor to compare to the virtual part. So, the idea is to virtualize which makes it of course obviously easier to implement, less expensive to implement. And democratize the use of the methodology. So those are 2 main goals in terms of project. And sustainability is always a dare. Being sustainability is a huge umbrella that covers a lot of things. I see myself focusing on more and more on the user experiments. Because I think it is very easy and the early processes were all. It is more obvious, resources, resources, more material part of what we consider sustainability. But at the end of the day, you design for people.

Before talking about people and behaviour, let us talk about sustainability first. There are many examples of diverse definitions of sustainability. And one of the most well-known is in Bruntland Commision's. Could you define sustainability with your own words? What does sustainability mean to you?

Again, to be honest, I don't think the idea of sustainability. Trying to find the best… I think it is really simple. It is being sustainable or sustainable behaviour is just looking at nature and see how the universe works, how nature works. It is basically that. It is best way to see it. The idea of the closed circle of producing something and the end of life of that product. Not only product but whatever. You are always taking some form of resource or energy converting to something, and what nature does really really fine is exactly that. Destroys something in the sense that consumes something and produces something. The thing that is produced when it's shelf life for the end of the day it just goes again to the circle again. So, it becomes again something that you can harvest. For me it is simple. And the definition the standard definition that makes sense. And I don't feel like it needs change. So, it is a false issue trying to understand very well. You have to find the balance between what you need and what you take. I think best word to define sustainability is balance. For instance, in fashion case. You just have to understand what you want to produce, how it is going to be consumed, and what you have to guarantee to put in again in the system that will be balanced what is consumed. The only thing that I could add which is not new is a circular idea, circular economy which I would say the only thing that makes sense. If we have this system of capitalism and consumption the only thing that makes sense is circular economy. The only way that you can produce profit that enables you to be compelled to deal the end result. The best way is financially appealing to deal with that. If you have all actors on the main key points where things are produced and destroyed, consumed and destroyed, basically if you have key actors that have financial gain you have that drive to put it again on circulation. Circular economy definitely is the best and the only thing I would like to add to that is the perception of what is something sustainable. I think you should understand sustainability as the measure of least impact. Because normally when you think sustainability is something that doesn't have an impact which is false. Everything has an impact. When you have that mind shift between, not having impact or "this is a green product". This is a lie of course, it is not. The thing is, this product has less impact on resources for instance, there are different impacts. And what you need to understand is the impact that a product has, is compatible again with the equilibrium the balance between what you are taking out. If it is, you could consider there is neutral. Because you are putting in much more or at least the same that you are taking out. So, you produce a balance. So, it is not the idea of not doing things or not destroy. You will always destroy something to produce the new things. The idea of impact is always present. You just have to understand is what is the minimum impact that you can produce to have something. If you shift your thoughts from that I think it is more honest how you perceive sustainability and it makes more sense even in industrialized society the idea of industry. Because again, you are taking something out so you are destroying something or at least converting something and you have to balance that extraction. This is currently my way to understand sustainability. It should be a closed circle, it is all related to circular economy, and you should think in as the least impact that you are doing.

General Assembly announced 17 goals and 169 targets to stimulate the action in the concept sustainability including topics such as zero hunger, well-being, gender equality, education quality, climate actions and so forth. But more recently the approaches are focusing on cleaner production, social responsibility, eco-design, recycling among many other terms. Based on your experience, do you think we (I mean companies or researchers) are disregarding some of the responsibilities of sustainability? Are all the pillars of the concept equally concerned together or equally?

No. Yes, exactly. When you talk about sustainability, it is true. When you say a circular economy, an economy implies that you have a society and society implies that you have people. And those people have right to have a best quality of life. And that means all those aspects being physically as material like clothing or housing. But of course, education access for instance. Access information, access to even general knowledge not necessarily education, just to knowledge. Because it is different having access to education system and knowledge. These are different things. So that's why the problem of real sustainability is its complexity, it has a lot of facts. When I was talking about the social part of it, it is exactly about that because it is normally easier just talking about resources. It is a physical thing; it is very objective but when you talk about people, it is more subjective so it is harder to ping-point what it specifically means. Something having color for your light.

So, we are focusing on an easier way?

Yes, exactly.

In your opinion, what are the main difficulties or obstacles to sustainability?

Well, first is to realize the importance of it. It is a matter of accepting a sustainability is a way of doing something. I am talking about design in terms of solution and that is necessary. I think currently, not to generalize but the human race as a whole has some difficulty in understanding sustainability. Or at least let's talk about producing less impact. It is something that is not added-on and something that it is crucial for survival as species I would say. I don't want to get extreme but it is. At the end of the day, for instance climate change is directly related to our behaviour and habits of consumption which in turn related of course to how that consumption is provided which is related to design. To design something in a specific way to provide what customer wants or the service that the demand of the market. So, I would say that from the beginning the behaviour itself is an obstacle. To convince people to a different behaviour is better. I would say first behaviour than all and the state of mind. Way of perceiving is an issue. Then, of course you have economical related issues that has any big change in society demands investments, demands resources, financial and others to shift. And again, goes back to the way that we demand or perceive something as a problem because the only way for me to accelerate this process is if people start to demand. But again, they need to understand that is important to demand a different way of doing so you go back to behaviour. For instance Manzini, one of his paper, he specifically says that we have to change the behaviour of consumption, at least in initial stage. It won't be easy. You have to understand that you have to consume less, you have to change literally everyday habits. So, we are talking about literally every person on the planet. They have to change because it is very hard, or it is impossible to provide what people want at the right that they want continuously. We don't have the resources, the way to produce and to guarantee that. It starts with behaviour and the first obstacle is to change the mindset. Secondly, you have industry of course. To change the way we produce things does demands a lot of investment and again also who produces to be convinced that it is a need to change the way. Parallel to this one of the biggest challenges in 21st century is exactly that. How can we produce the same with less impact? It implies that you have to change the production methods. For instance, to get new technologies to produce same/better if you don't want to level down, but of course in a short period of time it is not possible. You really have to change the way of consumption. Even it is the first principle of sustainability. Just consume less. It is not recycling, reusing, reducing. The first one is to reduce. Recycling is the last one. And currently is the other way around. But it is way better not to have it in the first place if you don't need it. So, the first obstacle and the biggest for me is changing the way people consume.

Let us go to the behaviour side. How can a behaviour be considered as sustainable? If it can be considered? What does sustainable behaviour mean?

As I previously talked. For me a sustainable behaviour is the behaviour which people are aware that their personal choices have a certain impact. They are able to measure somehow that impact is minimized or at least have a way to return that impact by just choosing things that are better designed, last longer, choose to consume less, consume what you need. That awareness is one of the key issues so I would consider that to be obstacle/objective to fulfill is, how you can make people definitely aware of their true impact of their choices.

How can we make people be aware of sustainability? They are smoking and they don't care about their own health. How can they care about the environment and future, their grandchildren?

It is hard. I think it is related to the complexity of the shier massive data that you have. But how do you make it perceivable? How can you easily understand that? Your option as a consumer to choose better. It implies that you have an information about what is better regarding to another thing so you have a comparison.

To give choices?

Exactly. And that means that you have to have some sort of easy, very straightforward way to present something that is not straightforward. It is also a huge challenge and not just produce something more sustainable or to has less impact but how you can inform people of that change or better performance. Imagine, you have a product: a car. You should be able to tell people when they are into buy a car. What is the real impact of each vehicle of their choice? This means that you have to have all the information from the raw materials, where they come from, what is the energy put in to transform them, the energy to produce the car, the lifecycle analysis of the car, for example if it is a diesel what is it going to pollute, if it is energy where is the source of it? And all that should be brought down somehow to an index or a level that people can see as in energy levels A, B, C in Europe. It is mandatory. If you have a washing machine which has an index from A+ to whatever to say it is more energy efficient.

Do you think this can change people's minds?

Definitely. I think you can change. First thing, have a way to present that complex information in a very straightforward way, very easy way. That is very important. So, you have to gather first that information and transform into an index or some visual easy-going index. The other thing, even then will people opt for it, because for instance you have price, involves a lot on your decisions which is driven by industry and demand as well. So again, this is always a cycle. You will start to approach the cycle as more and more people are gaining conscious of their impact and you have to have some initial monetary power, you have to have some available income, so that you can buy something that is more expensive. You are choosing to do that. And that group of people start to bring as they grow in number and more and more people start to buy so it is a cycle. Also, it demands time and even takes generations sometimes. It is not in 3-5 years but more. Again, it is a behaviour and you cannot force people to opt. You have to let them choose. For me the best way is to give good information, credible information and let people to choose and present the case. Price is great constrain in sustainability. In parallel you also have education which is paramount. And you have to work with kids, it is a best way. If you consider generations, you have to start with the generation where it is easier. Kids are much more easier to convey good practices. As we get older, we start to deform our minds to convey to some aspects of society. In this case, kids are very good because they could influence adolescent. As you can see you have changing behaviour which is the biggest challenge to achieve sustainability, change how people consume and also not only consumption. Again, I am a bit focusing on the physical part of the sustainability. For example, social part. It is how you relate to the next person and how you understand that a new investment and something that is immaterial as it is in the school system and how that will convey the society. Because people would be more informed and have more access to knowledge so they would choose better at least in theory.

In theory?

But it is still the best way. Independent people do better or worse choices. I think it is always the best way to go. It is the only democratic way to go at least. If you are not forcing people to choose again, you cannot force people. You have to give them tools to choose wise way.

Don't you think that forcing sometimes might work?

Yes, it can. At some levels, yes. By law. But it has to be for very specific things, in very strategic way. It must be very well thought, not to interfere or not be in interpret as an imposition. I think it is tricky. Of course, for example the problem of plastic. It is very easy case to argue from the beginning but only now that the consequences are being very obvious and photographically expressed.

I guess they will stop selling plastics in markets soon…

Exactly. The problem is so huge that it is impossible to look away. For me, it is sad part. Things only change when they get really huge. Well, but still ok. If they change, it is positive, so let us keep that in mind. These cases are material related. Way easier to just impose, ban or force manufactures to change the practice of producing something. And it is related with accountability which is something in a very liberal economic society. Sometimes it is very hard to accept the accountability for what you produce or what you gave back to society and design of course. It has a lot of responsibility in that sense. You could say "Oh, design should design better!". Yes, true. At the end of the day, it is just a job and just someone trying to pay his rent. It is very easy for us to accept that but sometimes it is not. Possible to go as best as you can in terms of sustainability but again, it is driven through what is being demanded. If people demand better, it would be a lot easier to do better things and produce better or invest money and other aspects of society that will contribute to a broader or real definition of sustainability, sustainable society.

Could you give me some examples what could be sustainable behaviours?

Sustainable behaviours… Yes, I think I can give you some examples.

Consume less?

Yes that is the most obvious and to be honest the most simple because it doesn't require any major information as I was telling previously. When you want to buy something, you choose based on information. This case, if you just do this exercise "Do I really need this?", it will be really simple. You just stop and think a bit, breathe, "Do I really need this?", "Do I need a second thing?" or "Do I really need to go there or spend this or that?". If we stop for a while and put things on the table, it would be a good way.

What might be other behaviours?

I think other behaviours are more complicated again they are related to your options. It always implies information. In your case you are talking about fashion, a practical example is exactly what you said. Just "Do I need a second pair of jeans?". Of course, I am exaggerating here but "Do I need my twentieth pair of jeans?" So that would be the first thing. If I don't need it, I am not going to buy it. Because you understand that it has an impact. Of course that option implies that you are at least aware of whatever action that you have, have an impact on the system. That would be the first thing. The second thing would be "Ok, I am going to buy a new pair of jeans, so what do I have to consider?". First, materials, where is produced, how are the conditions of labor. If it is very far, if it is local because of transportation of the goods. So, these are more straightforward criteria that you can look. And then you can look at "Ok, this is a good jean in terms of quality, material, workers' condition", then you start to look at brand. Is the brand responsible in the sense that they give those conditions, how do they marketing, do I see myself in their philosophy as a company? You can go down the rabbit hole and get even more criteria. That would be for me a sustainable behaviour when you do that homework. For me that is homework. You are just doing your homework before you consume. Again, this is the tricky part because most of the people will say that they really don't have time to do that or would say they have time. So, to eliminate that part, communication of that information in a very straightforward way even at the point where you are going to buy something. You are literally at the shop, you look at the things, you have all this major information, you just decide that the selling point.

If we restrict these examples of sustainable behaviour in the context of city life or being a citizen, can you give some other examples?

I talk about areas. This transportation is huge. Let me just go a bit more than just responding the other examples, I would just advise something. I would look which are the areas of the topic or services that have more impact. Literally more impact in terms of consumption. For instance, food. Reducing food is something consumes a lot of resources. And again, socially, it also has a huge impact. That is why I started always with material part because it is easier just to give an example. So, it demands a lot of food, water, mobility. It demands a lot of communication for instance so these 4 are at least very important to have a functional city.

What do you mean by functional city?

I can go from my house to my workplace, it enables me to do exactly that. And be at the work, if I am not able to move in the city because I don't have in infrastructure, I don't have efficient way from point A to point B, it's not going to work. If I don't have water or food, how would I maintain myself in the closest space that doesn't produce anything? So, if I cannot communicate then it totally blocks my life. Even nowadays, we are so dependent on the internet. The idea working without internet is almost primitive now. And this was just ten years ago. And those systems, and again I am referring to these four systems (probably they are more), they have a huge impact. Starting from the most obviously in generically, in terms of resources that you have to extract and then transform. And again socially, because people have to work to produce those things is you don't have good conditions for people who produce, you are messing up with a social sustainability. So, food… Currently, there are a lot of avocados, it's a fashion now. It's definitely a super fruit, however I don't know if you know, the production of avocados, again looking at the industry how you can change a way to produce quantity not quality, it's a challenge. It is levelling up forests as soy does, as palm oil does, and now it is avocados. It's their turn. It is always the same thing. If you have to supply something in a huge amount, if you are still using very primitive ways to produce things, so that means that the only way to ramp up the extraction. In terms of social responsibility, it means that people will be explored normally, because you want to maximize profits so you will cut costs where you can do it is always labour. Labour environment in the sense that you don't necessarily follow the rules that are put being implemented. Again, it brings us knowing something and then being able to consciously choose. If people were aware, I would say it is good for a step and then people have to choose. And forcing those choices in a democratic society is very tricky. It is easier to do that to regulate production, raw materials and how things are produced. Because you are talking about again industry not necessarily affect the choice of people. You could say "Oh, but let's talk about people who have money". That's another issue. When you don't

have a lot of money and you have to eat, of course you just want to eat. You don't care where things come from which is totally acceptable.

Can we say when we are poor, we will be more sustainable?

It depends. You can be because you just consume less which is a very bad reason to be a sustainable. Or, you could probably have more impact to be less sustainable, if you want. Because you are forced to make choices by products or services which are not well produced or designed. But of course, you can put a guilt or the problem that people don't have anything. It is just absurd. That goes back to accountability. Who produces, who makes money? In a capital system they have to be accountable somehow. It will not be possible to have a fully sustainable society, if the ones who produce, are not accountable for what they produce.

Do you think city life has additional impacts of people's everyday life by opposition of living other locations like suburbs, mountains?

It does, of course it does. It is interesting question you can say of course city has more impact in the environment, social sustainability of people, their well-being or health. I also think it does but it doesn't mean that the city is not a good structure or it is not a good way to go. The problem is, another issue for me in terms of sustainability is scale. The problem is scale. Everything that passes a certain level, starts to be unbalanced to maintain. A good example of that, I don't have data on this but it exists and it would be really interesting to understand, which is the tipping point where humanity started to be unsustainable in terms of resources, being in the planet. Definitely there has to be a tipping point where society reach to certain level that the earth lost the ability to renew as fast as we are extorting. There has to be a moment in history of humanity, that happened. The problem there is related to scale. As people and cities are scaling up, you need more resources to maintain it. So, scale is important. Of course, if you are alone in your large wooden or mountain, your impact is not even relevant in nature because your scale is very small. But at the level of city it is different. If you want to sustain cities, which is a good thing, cities are very ingenious way to increase the quality of life for a large number of people. But the thing is again, how do you produce the same or more with less or in a more efficient way? A good example for me, a best way to supply food for the growing population that conveys quality of food and reduces the energy missions and consumption, it is a hybrid between what is green house and what is called organic production. Organic in itself is not going to work obviously because organic is what we did. I mean initial farming was organic. We just put the seeds in the ground, it went up and done. You don't put a lot of things into the system to produce, so energy rises very low. But again, if things scale up, you need more so that process does not fit currently. It makes sense in some aspects definitely because it has to do with regulation, it has to do the way that you produce massive things. You are trying to test new practices that will guarantee that some abuse in chemicals are more regulated. But in terms of scale, you are not going to produce enough food and cheap enough for everybody. In the moment that you do that, you are not making a sustainable society. Because the poor will not have access to it. It would be totally unjust. A middle ground between what you know from industrial farming and organic farming is a lot more sense for me. For example, like vertical green houses, producing locally, people trying to design buildings in cities, there are self-sustained that makes a lot more sense. If you are going to use a big chunk of land with a building, it makes sense that you can lower your carbon foot print by producing some water or food. So, it is definitely producing something locally but it uses technology. Knowledge that you have to produce more. Of course, this is debatable, at least not proven. The problem of scale is also a bit step for sustainability.

In your opinion, what are the main reasons of people to adopt unsustainable way of behaving? What might be their reasonable internal excuses or reasons to behave like that?

Ok. That is tricky because you can easily start judging people almost in a moral bases which is stupid, doesn't make sense. Things should be fact-based always. Again information, again knowledge. But of course, people have all the reasons in the world, some more objective like "I don't have money", "I have 5 kids to feed". These are very objective reasons to be more sustainable or at least not have more impact by choices of consumption. But it never should be moralized, it is dangerous. First of all, morals are not interesting at least for me because morals are in the eye of the beholder, it changes with time, society, culture so it is volatile enough not to make sense. Ethics makes sense because it is something that you agree as a general, like you should not kill somebody which is very universal. And when it doesn't happen you would say "Oh, it cannot be" which makes sense. When you have a regime that kills people because they don't agree with it, it is not sustainable, at all. So, I am just saying that it is very easy when you start to ask that why people are having unsustainable behaviours, it is very easy to go that road of morals and demonize people for their behaviours.

It is not for demonizing but we are behaving like that. I am just asking what might be our reasons for it at least if we behave?

People are a bit selfish I would say. I am saying this just by saying that we shouldn't be moralize and so forth. It could be almost understood as that. But it is true that individualism which is something explored, I don't want to be seem repeating

myself but the way we behave as a consumer, it is related to our individualism. And I guess that it reflects, it starts to crawling to your other social behaviours and it starts to make you more individualist and closer into yourself. It is definitely related to the way you consume. Anyway, it is almost like a catch twenty. I understand this could be difficult to trace what is the origin because I don't think it is very traceable. I think it is after renaissance when man is put on the centre. I think it started there, to be honest. And after that, society started to be more and more individual at that aspect. Of course, it is a good thing in the sense that man is able. It doesn't need any supernatural entity or whatever. Man is able to determine his faith, to use his intelligence to make his life better which I would say a big revolution. On the other hand, for me the economical aspect of it, it explores that the most fundamental limit is that individualism which means that as a group we started to be more apart. In this context, people are not sustainable because they are not looking at the big picture.

Considering these reasons or obstacles for sustainable behaviour, you think fashion can overcome?

It could definitely help. Because fashion industry has a lot of carbon footprint or instance. If you could change the perspective of that industry could definitely help a lot.

Do you think fashion can change behaviour?

Definitely. For me, fashion is related to a life style the way you present yourself to the world. So, it has that huge impact, huge impact on how we perceive ourselves and how other people perceive us. So yes, definitely. I would be little broader, not just looking at the close, but more about that, if fashion is able to give good examples, if is able to educate people (again knowledge) and you are able to present them in a very fashionable way, I think you can definitely educate people. You have bad examples of how that works, I am saying bad in the sense that educate people in an unsustainable behaviour, I think you can do exactly the opposite. A good example for me is Apple. They manage to build people; they offer a lifestyle. They don't sell phones, tablets, they sell lifestyle. And people identified with that lifestyle and of course consume their products. They have a way presenting themselves. So yes, they definitely have a power to change behaviour, power to educate in the certain direction. And being fashion very powerful that permeates a lot of aspects of our life so definitely you could influence in a positive way and you find some examples again very primitive still. But for example, with Nike sneakers or jeans that are done with plastic recovery from the sea. So, they are trying to educate that there is a problem and you could try to solve it by in this case recovery material and transform into new products, basically giving a new life. For me, there are very small examples of something that could be broader. Imagine that you are able to devise a strategy that it is cool to be something that is more conscious, that is cool to make those choices. If those choices are visible and when I say visible, you could think social media, social networking, all those very fast disseminating platforms definitely could be used as a way to change people's behaviour. It could almost be like a game. That could be a way but again, how you deal with is difficult. But definitely yes, I think fashion can change a lot.

What about technology?

It is the same. Technology is a tool. I only see as that not the angle in itself, but a tool. I was talking about social media, it is impossible without technology. What I am saying is not necessarily new again, Apple uses brutally social media and all those networks to convey their message. Internet is paramount and when you look at Apple, they have that "fashion" approach. They design their products to be fashionable, to be sexy, to be appealing. When you start to construct these words these criteria, you look at fashion and I can see the parallel. I think you can do exactly the same. Look at fashion; how fashion communicates, permeates society and try to see mechanisms that the use to convince people to do something to wear something. You could try to use that knowledge to your benefit; to change behaviour to something more sustainable. So yes, definitely.

Do you think fashionable wearables, smart clothes, smart accessories can change people's behaviour? How?

If that enables you to have access to information in real time in a very easy way about your choices, yes. Definitely.

This question is basically directly related with my doctoral thesis. And there is no easy way to answer for this. What kind of sustainable behaviours can be promoted smart fashionable products in smart city? Or in urban life?

We already talked about it, option of consumption and you are buying something that informs you, just give you the information. If that is something on a jacket or any clothing or something just that as you said jewellery that could just whisper you something almost like a demon or an angel. Buy this, buy that. No, I am kidding. But it can give you information by just sending somewhere, some place.

If people are notified all the time, do you think that they would be irritated about this?

Well, you opt to be informed. This is not something mandatory. It is not like I buy a t-shirt and the t-shirt is always talking to me. No, it is not the idea. It is something that you understand that is embedded, understand that you want to have that

information. For instance, you have feeds on your cellphone. You have some specific feeds because you choose to have them. That is why technology and behaviour change is not apart from education. You have to be willing to participate. If so, then you choose to have something that is able to give you that information in a specific time and it doesn't have to be always. This might be just when you are going to do some specific action like buying something or opt for something and you might want to know about it and you will ask the system. Of course, it does imply an infrastructure that is able to communicate a system that is interconnected, internet of things and so on that is able to provide that information. You are not that far from that infrastructure; we have cellphones for instance. They are the major source of portable information. Even the realm of science fiction is very possible. The problem for me is always the same, how you will convey that information to people in a very straightforward way.

Considering everything we talked today, do you have any suggestions, advise or any traps I should avoid coming to your mind related with this research?

Traps. One of them don't be judgmental, don't judge people. Nobody likes to be judged. Don't force information, of course it has to be something that people are willing to accept. In terms of product, be careful how you integrate things. When you start to fuse different technology, you have to consider the lifecycle of the product, how it will end and separation of electronics in fabrics can be something that is complicated. So, it depends a lot on how things mesh up or fuse which tends me to think about this in a more modular way. Something that is not necessarily dependent. It is wearable because you can put next to your body but I don't think it should be wearable in the sense that is embedded in every clothes. It is something that you just put on. So yes, jewellery is a good example of that. Because you do not throw jewellery when you change your shirt. But it is still wearable, it is with you, it is close to you. If that technology connects something that is omnipresent. Phone is a good way to harness the power. So, this technology harnesses the power of the phone and the wearable in itself almost like a peripheral like a phone or something that you just add on. You are making it cheap and probably low energy to produce which is a good thing and you can reuse it. It is not dependent on the clothes. Of course, it is dependent on the style of the fashion. To promote that you could go further and you can have that is just a system. Imagine like you have a battery, system itself is something like an object of battery, like a cylinder that you can put on shelves and those could change related to fashion. And also, it is not very good because in itself, the shelf is going to be wasteful but again at least you are thinking about how could things deconstruct. So yes, definitely if you are going to try to do something that is physical and it implies fabrics, I would try to do something that is not fuse to the clothes in itself. It could be just a pocket.

Date: 28.02.2019
Place: IADE-Universidade Europeia
Expert 03

Could you briefly tell me about your professional career, projects that you participated/ coordinated related to sustainability?

I think sustainability kind of came due to my professional path. I am a graphic designer. I was trained as a graphic designer in Brazil and graduated 15 years ago. Pre-early in my career, I started teaching in a college and I was 23. So, I didn't know much, I was just repeating what I had been reading and all that. I didn't have much professional experience and I needed to teach design. Design is very practical and I am very practical kind of person. I like doing projects; I don't like theoretical lectures. After couple of years of teaching, I started to do some freelance work because I was teaching at nights so I had plenty of time during the day. That freelance became a company, and that company became a bigger company. Things kind of add up like I wanted to do right in the market like not sell my soul. So, I wanted to do design as it was supposed to do. Also, I didn't want to become too theoretical in college. My practical work helped my theoretical work; university helped my company and my company helped me be a better teacher. I wanted to talk to students about the projects and I wanted to know what I was talking about. It was a win-win situation. Somewhere in 2010/2011, I was asked to help creating a post-graduation in design management and marketing so I sit with a bunch of other professors. Post-graduation in Brazil is different. It is not like here (Portugal). You need to have a degree to go to post-grad. It is kind of a master. It is a specialization in your area. So, it was a one and a half year. I was responsible for a discipline called "Design innovation and sustainability". That was the first time I got in touch with Manzini's books, sustainability in a more academic approach; not only listening lectures. I needed to know a bit more. That was my first time trying to understand products lifecycle, the impact of our choices, theories from cradle-to-cradle. I also took a course on eco-design so that I could understand a little bit better on that. So that's when I first started to think about sustainability. And later, I started questioning the projects that my students doing. I thought they were kind of empty like. I started from the brief. The design brief that I was proposing wasn't really challenging and had no real impact. I used to teach packaging design so I tried to look into the environmental point of view but not very much. And all the briefs that are proposed that pretty much make beliefs. I would think about a brief about packaging problem and propose them. But I started to think that they needed to understand that design has an impact. Also, with other methodologies

that was trying to be developed in my class were like how would they deliver a better project, how can I teach them how a design methodology work. I was trying that for years in my class. And I thought I have a good thing there. So that's when I go for my PhD. My PhD was pretty much about teaching design through problems, through projects. And here in Portugal, it started to go from there and add up a new layer which was through problems but also with impact. So, the sustainability part of my work became stronger when I started my PhD.

There are many examples of diverse definitions of sustainability and one of the most well-known definition is in Bruntland's report as you know; it explains it as development that meeting the need of present without compromising the ability of future generations to meet their own needs. Others like balance between 3 pillars: environmental, social, economic... Could you define sustainability with your own words? And what does sustainability mean to you?

I don't know if I can, but I don't think that in the overall we understand what sustainability means. Sustainability was pulse to mean that it sustains itself throughout time. Something that can be resilient and sustain itself throughout time. We as human-beings, we don't have a good appreciation of time in a long term. We have a short memory and we don't really care about what is going to happen in the future. So, it is really hard for us to internalize the concept that we don't need all that we have. But also, we don't want to give up everything we have that makes us feel good. The thing with sustainability for me, even though it is a great concept, it is really hard for people to internalize. All bunch of small decisions that we have to make whether what I buy for myself is produced in a sustainable way and what is a sustainable way? Because how many little decisions we are making when we buy a shirt for instance? Or when we print a piece of paper? Who produced that? What kind of community was impacted by that, what is the social, environmental, economic impact on that? Even though it is kind of easy to define sustainability and it is having a sustainable way of living, something that is not being thrown away but being always renewed. Even though it would kind of clear that it isn't easy for people to understand. We are talking about a community. Sustainability cannot be done by a company or a government, it needs to be done by people. It is the choice that they made that makes more sustainable or not. A company can be more sustainable but if people don't believe in, don't buy, don't see the benefits on that it is not really sustainable because they will still have the same habits. I guess it is a cultural thing.

General Assembly announced 17 goals and 169 targets to stimulate the action in the concept sustainability including topics such as zero hunger, well-being, gender equality, education quality, climate actions and so forth. But more recently the approaches are focusing on cleaner production, social responsibility, eco-design, recycling among many other terms. Based on your experience, do you think we (I mean companies or researchers) are disregarding some of the responsibilities of sustainability? Are all the pillars of the concept equally concerned together or equally?

For my point of view, we as designers maybe not as researchers, we are neglecting sustainability a lot. From what I have been researching pretty much, almost every single design school doesn't have sustainability as a pillar or core of a course. It might have subject in the chair, course inside the whole course like eco-design or design for sustainability. But I don't believe that it can solve the problem. I believe that every single subject at design schools need to have a bigger pillar on ethics, sustainability, social responsibility. If you are discussing sustainability apart from the project, you might not embed that idea into the designer's mind. They might not understand how the product they do, impact to either the environment or the society or the economy of their country. So for us to be more aware, I think we need to shift education. That is what I am discussing in my PhD that this status quo now, will design that same linear way of designing. We need to shift that kind of education so that designers come out of schools that would be ready to design better products. It is not about being better anyway but it is about proper. Because you can argue that better if you have no goals on having the planet survival. I mean human survive, because the planet is going to survive. We will die. It is going to take probably a couple of years for the planet to restore itself. We are going to die for sure if we are still doing that and have no goals on surviving. We are designing good products, faster products, more efficient products but if we want humanity to live longer, we need to design differently. To have that design we need to change education. We need to take a sustainability from a part of course to the base of the course. Every single project that is developed needs to have that in mind.

In your opinion, what are the main difficulties or obstacles to sustainability?

History. I guess. We have been doing things in a certain way. People used to do that and it works. We like it. We are spoiled by history. Our habits, by our culture. And changing that means that you have to give up a lot. I understand that but I don't know if I am ready to give up everything that I have. Are you? Are you ready to give up your clothes and your phone? I don't know… It is not easy. It is very hard. Because you have been thought that it is a good thing to have a car, a big apartment, luxurious, to have a big TV, all the services, streaming, the latest phone…

If we shift this conservation to the behaviour side, how can a behaviour be considered as sustainable? If it can be considered? What does sustainable behaviour mean?

I don't know. The reason why I don't know is that everything is very complex like I have just said. Every decision that you are making whole bunch of little decisions, you may go to Celeiro (Portuguese health food store) to buy an organic food. But for instance, let's say that the lighting that they are using there doesn't come from renewable sources. Ok, I am buying organic but there is a whole bunch of other things, how about the people work in there? Are they being treated, being paid enough? Because sustainability is also about people. So.. It is trying to do the good thing but you are not always doing the good thing. I think the more complex, bigger and more interconnected the planet becomes, it is harder to be sustainable. You never know in what that decision takes a path to a non-sustainable way. You can try. You can try to buy a healthy food from a store but you don't know the fuel that trucks used to get there. So, a lot of different things are needed to be considered. There is this show called The Good Place. One of the parts of the show, they are trying to figure out why people don't go to heaven anymore. Even though you are trying to do a good thing, there are so many layers of bad things that you don't know or see. So, you never go to heaven anymore. It doesn't really matter if you have a good heart. Your decisions are always bad. I am not saying all decisions are bad but it became very bad because the system is so complex and there is always something that deviated from what is supposed to be sustainable. And I am trying to be pessimistic. I think to have a sustainable behaviour, first we need to understand that we don't need everything that we have. So having less, choosing or trying to be more informed about what you are buying, trying to avoid the urge of "I need everything" all the time and mainly understand what you are buying. How you go from one place to another, sharing more. I think sharing has a big part of sustainability as well.

Could you give me some examples what could be sustainable behaviours in the context of city life?

From the sustainable point of view, actually the cities are very good. Because usually when you have to distribute a service, to places to spread it is not a very sustainable approach. If you need to make water or electricity go somewhere, you need to transport something to somewhere and that transportation only affect a few people, you will have a large carbon footprint to access very few people. In cities, everything that you do, every little thing, you give access to a lot of people. In that sense, it is more sustainable behaviour than people live in country. But also, well it is hard. We can say let us better use the sun and solar panels. But solar panels are made of silicon and this is not a good thing, it needs to be extracted from…

So, are we failing again?

Pretty much. I think we are trying to figure it out because we built such a complex society but we cannot just start over. What would I do? I wouldn't have a car if I could, I would not necessarily take public transportation but bike sharing is a good thing, good for health and environment. City farming on top of the buildings, better use of sunshine…

Do you think design can change behaviour?

I think so. Because we are kind of behaviour-driven people. We usually do something if we understand that it is a right thing to do. And design for instance communication can lead us a path. So if you see a line on the ground, you may not pass. Through design, you can change a behaviour and tell a person and you need to make a right here. I know that it is very simple but if you can do that with simple things, you can do a lot more. Maybe a product to teach you how to behave in a different way.

Do you think we easily accept education? If we are aware of things, can we change our behaviours?

I think so. But it is not easy. We do accept education; we do accept change but I think it needs to be repetitive whole bunch of time until it is through. Most of our decisions are not very made conscious. From a repetition of that concept that we hear a lot of times, sometimes we just internalize it. It becomes a habit. Education has big part of it. That is why I think that sustainability needs to be in every subject in design course. If every single time you enter a class you expose that idea. When you go to the market, you have that in your mindset. But if you only have one time, that is not enough to drive a behaviour change.

What might be the major unsustainable impacts of people's everyday life?

Consumption. That is the endorphin that keeps you this pleasure in your mind "Oh that is so good!". It is like buying. When you buy something, until you get home and you see that again that buying has not been completed. You buy that, you put it on bag, you take it home, you open again and all the feelings come again and ok now it is completed. And we love it. That is why social media is so successful. Because we have been given small doses of endorphin all the time. You are looking at the feed and there is nothing interesting and suddenly there is something interesting and you become happy. You keep on scrolling because you have the idea that another happy moment is going to come up. That is pretty much consumption.

Do you think city life has additional impacts of people's everyday life?

What do you mean by additional?

For example, if we live in other locations such as suburb or mountains would we consume less?

Yes. Well, in terms of quantity of products that you buy probably it might change. I don't know if we are going to be happier or not. Because we used to this kind of life, I don't know how well we do if we change that and go somewhere else and don't see anybody, don't have a store to go to. But yes, it adds a lot.

In your opinion, what are the main reasons of people to adopt unsustainable way of behaving? What might be their reasonable excuses or reasons to behave like that?

I think it is not about excuse. They don't need an excuse, they learned to live like that. It is just natural to them, it is easy. It is just the way it is. Being sustainable is the opposite of what we have learned. The excuse isn't about not being sustainable. It is about being sustainable. Why do I need to be sustainable? Because everything else is teaching us otherwise. It is very comforting to have everything on your head to push an app and have someone deliver food to your house, not cooking at your home, that is very easy. Why should be people sustainable when it is so easy not to be?

Considering these reasons or obstacles for sustainable behaviour, to what extend do you think fashion can overcome?

I think so. I don't know how but first of all, we need to stop the idea that every single company has to grow and keep growing until it explodes. That is what happens in fashion as well. It needs to be growing and adding market chair and selling more and having better results and that is a bad thing. Until that model isn't overcome, it is going to be hard. When you look at profit, as the single thing that matters in business, you kind of close your eyes to a lot of things. Do people really need a new collection every two weeks? People really need to feel that they are not really using the latest thing they have. We could be vain as human-beings. I think the nature is vain. That is why animals have such beautiful patterns and why they do dances and sing songs, it is about conquering and we want this status. That is why history is the biggest problem. We have been doing that for a very long time. We had queens, kings, palaces and all the luxury. Now it is kind of for everybody. So that is everybody's turn to look beautiful, to make a name on themselves, to have an identity and being part of something, making a statement, right? But it is too fast. I was watching the Walking Dead couple of years ago and they had just got into the city that was blocked from everywhere else. They were having this meeting in living room. There was a TV on the screen. And I was thinking that TV never get old because they are not making other TV so that TV is never going to feel old anymore. It is always related with the latest one. People are not going to want to buy another one because there is no other one to compare. That is the problem with all industry that need to be making stuff all the time. Because every time we do something new, you feel like whatever you have is old. And it is a terrible feeling. It is like a competition; it is shallow but we like it. I think fashion can overcome that. It needs to shift the business model from selling product to sell a service that sells that this shirt is going to last forever and I can provide something else to you so that lasts forever. So, bring this every time it loses a button or the colour is fading, we can fix it for you. I don't know.

Do you think technology can overcome these obstacles?

It is the same. Technology has taken the same path as fashion. Every brand needs to unravel a new product every year, every six months so it won't look like. They are losing their competitiveness and so that stakeholders are happy with the results and the sales. If you look at the stock market, the stock value, it is very tight to the prime master results. If company have a good financial result, the stock will go up and if they don't, the stocks will go down. I don't think it should be like that.

Do you think fashionable wearables, smart clothes, smart accessories can overcome these obstacles?

I never have a deep relationship with wearables. I wore a Fitbit (activity tracker) for a while which was good. It was fun, my steps were tracked down, how long have been exercising…

Are you still using it?

No. Because it is broken. Anyway, so I think it was a good thing. The experience was awesome. It was good to see and try to establish goals for my days, I am going to walk this much, try to walk 5 sets of stairs or 10000 steps or do at least 30 minutes of exercise. It can. Fitbit has a good gamification kind of thing. Every time you accomplish something, they send you an email like "you just do this and that…". Motivate you to do more and to what is going to be next. And we see that Nike has some cool apps to help you keep running and train. So, I think wearables are pretty good to be healthier. I don't know if sustainable but healthy.

Wellbeing and health are also related with sustainability, though.

Yes, it is. Because the choices you do on not taking a car or eating better that is kind of sustainable if we talk about sustainability as living longer and better as well.

So, sustainable behaviour can be promoted?

For instance, let us say that you need to be at IADE-Universidade Europeia at a certain time and you have it on your schedule that you do that and it knows that you are home. Instead of only saying you should catch a bus, it might say think about leaving earlier and just walk there. It will take 40 minutes. Or even track your meals and also suggest try eating healthier or better. I think it is good to have that kind of melting in your head and helping you develop better habits, more sustainable habits for instance.

Do you think people like to be notified all the time? Will they be annoyed or irritated?

Probably. It is pretty annoying all the buzzing and all that. But we also kind of used to it, don't we? How many notifications do we get on our phones every time? I think it is better to have that on a wearable than have it on your phone. Because every time you take your phone, you kind of lose yourself in that screen. So "I was supposed to check something, what was it? I don't remember anymore because I have just accessed to Facebook or want to see article and suddenly, I didn't call whoever I had to call or I just didn't leave home. And I have to take car or bus. It is good to have notifications but I think in the smaller amount and it is very limited. I don't think a wearable should replace your phone. I don't like the idea of implying to tech on your watch, sending the message and something like that. It is just replacement and there should be a separation. It should be different.

Considering everything we talked today, do you have any suggestions, advise or any traps I should avoid coming to your mind related with this research?

The only thing is do it right. Don't make something so that people buy it because it is cool but it is useful. Be careful with information that you are going to gather with this device, how we are going to use them. That is my main issue nowadays with how technology is that I have a whole bunch of information that I don't want to give.

Date: 01.03.2019
Place: IADE-Universidade Europeia
Expert 04

Could you briefly tell me about your professional career, projects that you participated/ coordinated related to sustainability?

Well, I did a few actually. I was working with my students since 2000. And in 2006, I won a major contract, with a client it is our water provider EPAL which is a huge company in Lisbon, I won that before even I made my PhD in communication sustainable design. But I had been recommended because I had been working already for a few clients on the sustainable area. When I won that contract it really set me on the track of sustainability and made me look for more and go deeper and try to become more professional. But before I had done, I started working with FST which is not the foundation but the university, The Faculty of Science and Technology. They have a huge department of environmental course, they recommended me somehow. So I started learning because they were doing projects all about sustainability. I also had to learn more to provide a better work for them. So, I started to look for local suppliers, Portuguese papers, they donated the fibres, what was inside of the fibres if they are recycled. Everything was about that. It started on growing step by step. I was specially working for them, they asked me to go to many conferences, about governance and science… I mean not being showing off, for them it was a very nice and important, because I made an international image of our society. So impacted them and also impacted me, I really liked to work with them. I started to studying more I don't know how come I was invited for this contest with EPAL and I won. I proposed an advertisement campaign, instead of spending a lot on media like TV and billboards. Well, actually we made billboards but made it with a very specialized root. Instead of throwing them all away, I made a few small events and they liked it a lot so I won. Every special event was related with sustainability. One of them was sponsored by paralympic swimming team, the other was in the river Tejo which is the second main source of water for Lisbon. We invited people to go to the community and to enjoy the river and everything was made very carefully. We had a lot of details, anyway then I did my PhD but after, unfortunately, so many things came after and I couldn't come back to my studio, maybe one day I will go or not. I am not sure. So far I am enjoying a lot my new experiences.

There are many examples of diverse definitions of sustainability and one of the most well-known definition is in Bruntland's report as you know; it explains it as development that meeting the need of present without compromising the ability of future generations to meet their own needs. Others like balance between 3 pillars: environmental, social, economic... Could you define sustainability with your own words? And what does sustainability mean to you?

Let me go a bit back because I don't have a definition for sustainability. I have the one when I was working on my PhD which was in sustainable communication design. To have that, one of the hardest things was not doing the research itself, but it was how to see myself in the research, how to focus. In the terms that being a communication designer, it is very easy for

me and for designers to stand in the middle. I work for my clients to a general consumer. I do what they ask me and I deliver. So, it is very hard to see because I cannot force the clients. I can suggest but I really cannot say a client "No, no you have to do this or that". One of the hardest things is how I can see myself on this. So, I have learned after a while of researching through my own experience. The only thing I can do is on a more ethical perspective. My approach was how I can -as a designer- contribute in my studio, in my work, supervising the clients, informing the clients and delivering also more informed outcome. For instance, how they can recycle, reuse the materials and so on. So yes, my definition of sustainability is a way of conveying a message in the way that we look for a better sustainable result. The question is how can I contribute, providing a better (sustainable) service, informing the client and allowing the client to do a better work.

General Assembly announced 17 goals and 169 targets to stimulate the action in the concept sustainability including topics such as zero hunger, well-being, gender equality, education quality, climate actions and so forth. But more recently the approaches are focusing on cleaner production, waste management, social responsibility, eco-design, recycling among many other terms. Based on your experience, do you think we (I mean companies or researchers) are disregarding some of the responsibilities of sustainability? Are all the pillars of the concept equally concerned together or equally?

This is a very interesting question because I think this is the most frustrating part. It is so systemic and so complex that is impossible approach all sides. It is impossible to be 100% sustainable. Once, I met a professor and he told me well, the moment you are doing you are already contributing for a global warming, for garbage, for emissions. So, the concept when you do something is how to offset, how to minimize the impact. Because it is the one that you decided to do something you are already contributing. This sentence made an enormous impact on me because I truly understand how humble we are in this process. It is so much and so big that it is very hard to be 100% sustainable. I think it is a utopia. On the other hand, I found it very frustrating and I think this is the reason why I have not pursued the path of sustainability. It is nothing like you can always achieve, you can only do a bit from this and a bit from that part. It is easy to say "Well, I am working on an eco-friendly product or material", but what about the people, economy, environment, impact… We are moving on the concept of circular economy which I really like.

In your opinion, what are the main difficulties or obstacles of sustainability?

I think it is the third parts. For instance, as a researcher, I think it is very nice to work with people and involve them to think on the social aspects. However, as a practitioner, I found it very hard to work with a supplier on the contrary. Not just suppliers because you will always find someone wants to pay, that will do what you want but it will increase so much on your price. Even your most committed sustainable clients won't go in sustainable way.

Let us go to the behaviour side. How can a behaviour be considered as sustainable? If it can be considered? What does sustainable behaviour mean?

Sustainable behaviour means that you have to do such an effort. It shouldn't be like this. Solutions should come step by step to you and help you to improve your daily behaviour. It depends from doing everything on yourself, it is very hard. We have thousands of things. I have to split my garbage, and so many different things I have to do. Sometimes I have now a few printers that are broken already. I kept them for months in my truck because I need to go and pick up another one. Then I have to take them 10 miles to a place that they can break it apart. They also give me a certificate that I need to put it in my company saying I have delivered them for a special price. Yes, it means that I have to combine all of them so I have been living with my printers in my car for a long time. What I think is if it depends on me, being 100% I can't. Because I am overloaded with my work, with my children, my daughter. So many things are waiting for me to do.

Could you give me some examples what could be sustainable behaviours?

I think having a conscious. For example, we did this for Caixa Geral Depositos which is our main public bank. We did a very simple little book. It was an e-book. Everything they could do in their office and at their home to be more sustainable. We did it in the concept of, everybody stand for one thing. So, I disconnect the lights, unplugged all the office suppliers before I go, I disconnect the air conditioning. Everybody stood for one thing. They committed to this one thing, and when they saw their colleague is doing this and that, it really impacted the behaviour. We knew that is one of the things that has a positive impact. When my peers do something that I don't, then it bothers people. We knew this from the research already. We used that same concept and it was a huge success. Therefore, among the many things, most important one is to be aware of the information, the little things that they can do. General information is also important. For example, you are in the centre of fashion, it really bothers me today. When I go to some brands like Primark where you buy a t-shirt with 1 or 2 euros, it truly bothers me a lot. I don't do it. It deeply hurts me to buy these t-shirts that are being done by children in somewhere. I take my daughter and I prefer to buy a t-shirt that is 10 euros and make sure that is properly made. I used to adore shopping before but now probably with aging, I found myself tend to not satisfying or not accepting to buy so many cheap things then I throw away so quickly.

In a way, I am also passing that to my daughter. So, information is the basic of the behaviour. Knowing the impact, knowing what you really do, it is crucial.

If we restrict these examples of sustainable behaviour in the context of city life or being a citizen, can you give some other examples?

For instance, take an electric bicycle or just walk. Many times, I wish to come by bike and I try to come to work by underground because it is very easy for me. But then I have to go and pick up my daughter, I walk with a bag of 6 kilos and take 2 bags mine and hers and so it is hard. So yes, being in a city, walk more, using public transports, also again the electric cars. They are also a problem because of the batteries. Once you go digital, it changes things. It is like our cameras, when we had analogous camera, we were using it for a life time, but when I have digital ones, I think I have 6 or 7. Technology is changing constantly so that the features are changing and you can't stop renewing with a better one. I think this problem will also come with electrical cars, they will be plugged and be charged faster, will get better and the price for decomposing those batteries for each use has much more impact than the old car. So, it is not easy. That is the thing which is so frustrating about sustainability. When you come up with a wonderful solution, it won't be in a few years. Many other things can be. Fashion for instance. It is a huge problem. Well, I used to love the luxurious brand and I still do but somehow something changed in me. Maybe because I have more information, maybe the process is becoming clearer in my mind, maybe I watched and read many things related with unsustainable fashion; I don't consume that much anymore. So, it can be many things but in the end you can change.

Do you think design can change people's behaviour?

Of course. I don't even doubt it.

What might be the major unsustainable impacts of people's everyday life?

It can be so many. I think we have so many that we don't know. One thing that would be very nice to have the information about where we are in sustainable. Very few people know that 10% of the emission comes from the fashion, and everybody thinks that it might be electricity or the gasoline of the car. Of course, they all contribute but in the end just one t-shirt or one pair of jean have an huge impact.

Do you think city life has additional impacts of people's everyday life by opposition of living other locations like suburbs, mountains?

Yes, a lot. One of the things that stroke me more is the text that I read. It was about how we need a connection with nature. It is also something that I experienced. We need the nature, I think when we live in the cities all day all night, all our life. And then we experience going outside, living with trees, grass, birds, sea... I think it comes something inside of us makes a huge impact on us. We have many cultural aspects, health aspects that can be plus in the city, hospitals, doctors, schools. But at the end of the day, not being in touch with nature is a huge avoid.

In your opinion, what are the main reasons of people to adopt unsustainable way of behaving? What might be their reasonable excuses or reasons to behave like that?

I think it is easier, cheaper. Not knowing the difference.

Considering these reasons or obstacles for sustainable behaviour, to what extend do you think fashion can overcome?

I was in a conference in Finland, and I learned this from a colleague. In the 50s, many clothes were handmade, they all look so fashionable. Why now we dress from these end-market brands and look so horrible? The way we upgrade fashion patterns for the different sizes, it is not made well so it doesn't fit well anymore. Why? Zara want it to be. Because if you see it first, you like it, you buy it, then you go home, wore it 3 times and you don't like it anymore, so you throw it away. That perspective was made on purpose by Zara. I don't know, I am not sure. I was very curios and she convinced me. Since that I saw so many times that clothes from Zara that I wonder if that is not just the purpose, there is no way how that fits anyway. It just fits so horrible even in skinny person. But anyway, I really liked the conference. She showed how patterns are not developed well in bigger sizes. Not well constructed. In the end, you owned the thing. And when you have your clothes hand made, it made a lot of difference.

Do you think technology can overcome these obstacles? Change the behaviour?

I think we will go to the path that we put all these sensors in clothes, tell us the humidity, temperature and things. But I think it will be like the electric cars. Then we have sensors, then how we will recycle the sensors, then we have more sensors and batteries. I think I prefer the old t-shirts. I prefer a 10 euros t-shirt that was properly made in a factory here in Portugal, made

from a nice cotton. If possible, made here, or paid in a fair way to a small provider. I prefer to have 5 t-shirts and each one cost me 20 euros, perfect.

T-shirts without technology, so you don't prefer sensors or anything?

No. no.

Do you think smart clothes, smart accessories can overcome these obstacles? Can they guide them to change the behaviour?

Not that I can see of it. But if you tell me, if it's for health reasons, then of course I would approve. I will find it interesting and even cool. If a t-shirt tells me if my blood sugar is low, if my heart beating causes a risk, if I need to calm down or take pills, this is nice. So, yes if it is a health issue that is vital and makes my life easier. For example, my mother-in-law has an Alzheimer and she is losing weight. If she wears something that informs me about her or informs her about her medicine, introduce her "This is your son", I would love it. So yes. But not as a gadget or plugs, not for me. We should go simple.

Do you think fashionable wearables, smart clothes, smart accessories can overcome these obstacles? Can they guide them to change the behaviour?

You might have an interactive tag that tells you what it has been made, by who, from which sources. You can also find it in a paper of label with a QR code. You can have a rate now like we have it on supermarkets like Continente, they have a code on food that tells about ingredients. In clothes' case it might say you it is made with cotton or not, and supervise suppliers if it is children work. If it would give me information yes, if it will be for health, yes. Well, of course, I cannot shut my eyes to technology. For example, they are making this city in France for Alzheimer people for them to be more comfortable. So, I can imagine that can connect using colours like we are in the same house, we have same colours, we are together red, great. For sports, I can imagine measuring the heartbeat. If it really gives you something important, data that is important for you to choose or understand.

Do you think information can change people's behaviour?

Yes, I think so.

For example, people are smoking and it has harm. They continue smoking even though they know the impact on their own health. Do you think when they have information or are notified, this can change something?

That is a very interesting. I used to ask myself that question. What I have read about that there is inside of us a mechanism that makes us self-defend. We have a self-defence mechanism that tell us "that won't happen to me". This is an important mechanism; without it, we would be so worried. We may not go out of streets and be frightened of being hit by a car, or other worries in daily life. We have naturally embedded in us this optimism and we need this also. And we have same self-mechanism that we trigger when we smoke tobacco. So, we see the message but tell ourselves this won't happen to me.

Considering everything we talked today, do you have any suggestions, advise or any traps I should avoid coming to your mind related with this research?

Well, it is hard and very challenging, so congratulations on that. I think you should think what is sustainable, it is the cloth, it is the item itself or it is the information that you are giving, and therefore you are working on the behaviour. It is hard to work on everything. Are you working on the expectation of people such as if they are informed well, they will change, or are you working on the technology on clothes that will be sustainable all? If I were you, I would work on a line of clothes that can be sustainable. I will be giving them options, very well designed, very cool and sophisticated.

Date: 07.03.2019
Place: Cascais School of Arts & Design
Expert 05

Could you briefly tell me about your professional career, projects that you participated/ coordinated related to sustainability?

I have been a designer since 2000 roughly. I was working in a design studio for nearly 8 years. During that time, my connection with sustainability was very slow. At the end of that time I started to do my PhD because I was always interested in sustainability and the relation with design. It was only about 2006 when I started PhD and researched for sustainability and design. My PhD was about what tools could furniture designers use to develop better furniture regarding all areas of

sustainability. So not only ecological aspects but also social aspects. How could designers integrate that in the design process was my main question for 5 years. Everything has been related and tests, products, tools and methodologies regarding design process and how can we work to integrate easily sustainability criteria in the design process. Of course, as a teacher I also tried to understand how can I pass that information to students. So, I also developed some research regarding this design education and the relation between product design, sustainability and design education.

There are many examples of diverse definitions of sustainability and one of the most well-known definition is in Bruntland's report as you know; it explains it as development that meeting the need of present without compromising the ability of future generations to meet their own needs.

That is sustainable development. It is not the definition of sustainability.

But the end point is sustainability, right or not?

Well, I think I see that definition as a process towards sustainability. But it is an end but it is not an attainable one. Because sustainability is something always shifting, changing so we have to continuously improve and change our process. The sustainable development is not something that we can implement and "Ok, we are doing a sustainable development therefore we are sustainable". It is something that you want to achieve but you never achieve.

Could you define sustainability with your own words? And what does sustainability mean to you?

Without trying to be very dark, sustainability is the ability as society try to encompass all the areas of human development and try to harmonize that with ecosystem so the function of the planet. I don't know, I don't want to give you green respective. Because although I am working on this area and keen on this area, I have 2 daughters and it is a main drive for me. I am not very optimistic regarding the functional society and all that. Because it is such a complex area that deals with so many levels of human activity from the political and international relations, and also under personal level with simple tasks of theses so why do I approach? So it is very difficult to implement that approach.

General Assembly announced 17 goals and 169 targets to stimulate the action in the concept sustainability including topics such as zero hunger, well-being, education quality, climate actions and so forth. But more recently the approaches are focusing on cleaner production, waste management, social responsibility, eco-design, recycling among many other terms. Based on your experience, do you think we (I mean companies or researchers) are disregarding some of the responsibilities of sustainability? Are all the pillars of the concept equally concerned together or equally?

I think all of us disregarding that. Not only we as citizens, our behaviours but also producers, designers. So everyone, all the stakeholders at some point are disregarding, missing something.

Which part is missing?

It depends on what area, which company. I cannot give you one specific answer. In all areas there are people and companies and institutions that are trying to go for it in the right direction but here are also others are laying behind. So, some parts they don't care, not their concerns.

In your opinion, what are the main difficulties or obstacles of sustainability?

I think the main one is the complexity. Since it is very very complex. So, it is very difficult to approach. There is no one answer to it, so there is no one solution. To try to implement sustainable development or sustainability we need several approaches so everyone should work together towards that. There is not one solution that is missing, most of them are being missing. Although we know some of the solutions, some of them are not fully implemented. And we have got history of just say in political level, protocols, Rio summits and all the other summits that came after, and all the agendas that are being defined, all of them have been somewhat not implemented. There are many principles, steps that in some cases not the objectives are not quantifiable, in a sense that they don't have something well if you don't implement them ,you don't suffer anything. A country that doesn't reduce its pollution for example even though they have established that goal, nothing happens. So why should I care, right? It is something like that. Although the goals are defined there is nothing enforcement. This is on political level. On personal or citizen level, I think more awareness is needed.

What about sustainable behaviour? How can a behaviour be considered as sustainable? If it can be considered? What does sustainable behaviour mean?

I think it is related to the impact of that behaviour. If you have a behaviour that cause a negative environmental and social impact, it is not a sustainable behaviour.

Could you give me some examples what could be sustainable behaviours?

Let's clarify something first. I don't believe in fully sustainable behaviour and also fully sustainable product. It is roughly the same thing as we were talking about sustainability. Something we cannot achieve, here is the same. There is always some sort of impact when you develop an action or product. You can reduce that impact but it will always be there something. So, the correct phrase or expression should be "more sustainable behaviour", in my opinion.

So, how can we be more sustainably behaved?

Saying this is something that we need to compare it with other behaviours that we had before. It is not something that can be considered as alone in the universe. It is related with any other thing. So, you want an example to more sustainable behaviours? Any aspect of daily life?

For example, as a citizen?

Well, the mobility nowadays is one of the main aspects. We are always talking about electrical vehicles. Although the product itself has more impact on the environment than the non-electrical one. Because of the batteries, mainly. We are thinking about electrical vehicles and change the paradigm but maybe it is not the best solution. Because if you walk, ride a bicycle or use public transportation the impact is far better than the electrical one. So, the behaviour is not completely related with buying a product or not it is more related with the attitudes and fulfilment of the service. But that can be achieved with a product or not. I want to go from this place A to B but I don't need a car to do that.

Except mobility?

So many, so many. All aspects of our everyday life causes impacts. We are all surrounded by material culture. Everything is designed, produced and has an impact. When we are using them, we have already causing impact.

So, maybe less consuming or not using clothes?

Well, one of the thing that I teach my students is 3R policy: Reduce, reuse, recycle. Nowadays we think that we need to recycle and recycle. But that is not the order of the situation. We need to reduce and if we cannot reduce, then step 2 is reuse. Only in the end if these two possibilities are not available, then we recycle. So yes first, reduce the amount of the material in the objects, reduce the need of buying something, thinking if we can do it another way. This is the order.

Do you think design can change behaviour?

Yes. When we design a product, we are influencing the behaviour and the use of the product. I think that is the answer. I am not designing a chair to design a chair. I am designing it because someone will sit there and it will have some specific features, right? If we are aware of that we can influence users.

What might be the major unsustainable impacts of people's everyday life?

I think nowadays is use of energy. Because everything we use the gadgets, transports, all others consume energy. The ability of the country to generate energy is not gear for sustainability. If you have some renewable sources of energy that can be shifted, but we have need too much energy nowadays. I think that is the major impact.

Do you think city life has additional impacts of people's everyday life by opposition of living other locations like suburbs, mountains?

The urban living is much more efficient than living in the country. Because everything is much closer, together, we have public transport, water and electric networks, everything is more compact and efficient. Displacement of people is much more lesser. If I live in a house in the middle of the country and I need to buy a pack of rice, I have to go 5km for buying the rice. If my house is in the city, I just need to cross the street. The only problem in cities is supply, the things that are not generated in the city, need to arrive to city like suppliers of the food.

What do you think about the pollution and traffic?

That is mainly related with the type of transports that we have now. If you look at several places in history, you see, there are a lot of people riding bikes and so on. This sort of pollution was not the main issue. But with the development of personal car and internal compass engine that problems started to arrive. Also, if you have a lot of people in city, it means they work there or nearby. Normally, there are also industry around and some of the industries are very polluting.

In your opinion, what are the main reasons of people to adopt unsustainable way of behaving? What might be their reasonable excuses or reasons to behave like that?

Because we don't care. We think that it is not my problem, I didn't create this. I want to live my life as I want. Everything is ok so why should I bother or change my behaviour? I don't know if you know, there is a book called Environmental Intelligence. He says that there are 3 types of consumers. The ones that are really keen on sustainability and will do everything to reduce footprint, and sometimes they all will shut themselves food train to the death because they are eco-friendly and they run several geometers to find it. So, they are very somewhat fundemantalists. The other extremes are eco-septics like they don't care and then in the middle is big chunk. The normal people that somewhat aware and if you as a producer or designer present some solution that is interesting or affordable, they will probably opt for that. But they need to know what they are doing. So they need information to make the correct choice.

To what extend do you think fashion can overcome these obstacles or make them care?

Human behaviour is very sensitive to appearances. We live in a society with very fast-based and fashion is one of the areas that mark with it. In one year, you have 2 sets of clothes, all is coming and going. We are aware of what we interest what kind of things that the rest represents, how we represent ourselves to others. So in that sense, it is a very huge deal how can we change that peace of material of interest. In a way that it changes our behaviour. It is also one of the very difficult areas, because it is probably the fastest one.

Also causes a huge impact...

Because of that probably it has a big potential to improve.

Do you think technology can overcome these obstacles? Can it change the behaviour?

I think technology has proven in the past that can change human behaviour. We can see in the gadgets, i-phones, and other things. The society has changed completely. Few years back, you see group of friends that are talking each other, now you see the same group and they are all looking at phones and touching it. It is just an example. If it is possible to do that, in the sense of normal behaviour, that is possible towards a sustainable one.

Do you think fashionable wearables, smart clothes, smart accessories can overcome these obstacles?

It can help. Those kind of products are not sustainable. Like electric car. Something like... Because you have another gadget with electronic, chemicals and rare metals that come from Africa or wherever and the battery issue and so on... But it can change our behaviour. So throughout its lifecycle, it can have significant positive impact.

We are coming to end. This question is directly related with my research. What kind of sustainable behaviours can be promoted with fashionable wearables? Also, you can think in the concept of smart cities, internet of things…

Promotion of mobility, it is something. Better use of energy in house. If you are more aware of using your energy in your house, you can use it better or less. For example during the night you are asleep, you don't use energy, but if your gadgets prepared programed to use that cycle, you can go and catch energy at that period of time perhaps.

If we are aware of it, aware of the impacts, do you think we can change?

That is a though one. Because some people who become aware, they try to change behaviour, but most of the time it is not a permenant change. So, it has to be an easy thing to do. It has to be a change that we do naturally. Only a small percentage of people by their will, the others will not. So it has to be something that probably without them being aware of. You can change unconsious part of ourselves. If it is something that you are demanding from us to do a conscious change, then that has some kind of effort. It may not happen in the long run. I think it is better to start with that promise. With that in mind. People are lazy, so I need to find solutions to embrace this.

Do you have any suggestions, advise or any traps I should avoid coming to your mind related with this research?

Regarding you research question?

Yes, for example, behaviours, I need to narrow.

How can we change our behaviours when we dress something up, right? And when it is something that has technology embedded... What kind of information that gadget give us that will help us improve our daily routine, to know when the bus is coming, you need to find a specific area. Because like I said, sustainablility is so large and very wide. In a specific area of activity, if something is used in the house, something medical or for nurse... It can be through indirect way. I think you should identify the main impacts of our daily life and try to choose one or several, the ones are related or adresses the same thing. Either use of energy or the kind of things that we eat... The mobility, now the chemicals we use, tooth brush, tooth paste, detergents. If you identify that the main impacts, and came from where, from what kind of behaviours/actions originate

those impacts. For instance, main problem is climate change. It is related how our behaviour and use of energy. You need to identify what we do as a society and as a person that originate the problems.

B. Expert Quotes for Defining Sustainability

Expert	Quotes
E1	"Sustainability for me, to use correctly the link between 3 pillars: Environment, social and economic part. Without one of the pillars, you can't achieve sustainability."
E2	"Trying to find the best. I think it is really simple. (…) just looking at the nature and see how the universe works, how nature works. It is basically that." "You have to find the balance between what you need and what you take. I think best word to define sustainability is balance." "I think you should understand sustainability as the measure of least impact. Because normally when you think sustainability is something that doesn't have an impact which is false. Everything has an impact. When you have that mind shift between, not having impact or "this is a green product", this is a lie of course, it is not."
E3	"I don't think that in the overall we understand what sustainability means. Sustainability was pulse to mean that it sustains itself throughout time. Something that can be resilient and sustain itself throughout time. We as human-beings, we don't have a good appreciation of time in a long term. We have a short memory and we don't really care about what is going to happen in the future. So, it is really hard for us to internalize the concept that we don't need all that we have." "Sustainability cannot be done by a company or a government, it needs to be done by people. (…) A company can be more sustainable but if people don't believe in, don't buy, don't see the benefits on that it is not really sustainable because they will still have the same habits."
E4	"My definition of sustainability is a way of conveying a message in the way that we look for a better sustainable result. The question is how can I contribute, providing a better (sustainable) service, informing the client and allowing the client to do a better work." "It is so much and so big that it is very hard to be 100% sustainable. I think it is a utopia."
E5	"Sustainability is something always shifting, changing so we have to continuously improve and change our process. The sustainable development is not something that we can implement and 'Ok, we are doing a sustainable development therefore we are sustainable'. It is something that you want to achieve but you never achieve." "Without trying to be very dark, sustainability is the ability as society try to encompass all the areas of human development and try to harmonize that with ecosystem so the function of the planet."

C. Expert Quotes for Defining Obstacles to Sustainability

Expert	Quotes
E1	"In the 70s, companies started to understand the problems for environment. They came up with end-of-life solutions. But what they were doing was to solve the problem in the end of production. They had waste; they made some facilities to take care of the waste. They had emissions, they put some filters and so on. It was the end of the pipe, and that solution was not good." "You have to have a holistic approach. Not just process that you have to work on the product, and lifecycle." "Everyone talks about sustainability nowadays. (…) A lot of people don't believe in sustainability. It seemed as a flag for niche market, it didn't work as we expected. Now, in circular economy, we are trying to solve the problems that we are not able to solve with sustainability development." "It is an old-fashioned word and is being used in everywhere and the meaning is not what we want. Because people are using the word for everything so we are losing the meaning. Now, we need to be clever and be clearer about the definition and we need to demonstrate the benefits. Not just for the environment but for the society and for the economy." "For me, most of the professionals that are working in sustainability field are not able to demonstrate the benefits of the application in the context. From my experience, I have been working in a lot of project, in all our projects the idea is to evolve companies. It is really difficult to engage companies because they don't see the benefits."
E2	"So that's why the problem of real sustainability is its complexity, it has a lot of facts. When I was talking about the social part of it, it is exactly about that because it is normally easier just talking about resources. It is a physical thing; it is very objective but when you talk about people, it is more subjective so it is harder to ping-point what it specifically means." "Well, first is to realize the importance of it. It is a matter of accepting a sustainability is a way of doing something." "I think currently, not to generalize but the human race as a whole has some difficulty in understanding sustainability." "Let's talk about producing less impact. It is something that is not added-on and something that it is crucial for survival as species I would say. I don't want to get extreme but it is. At the end of the day, for instance climate change is directly related to our behaviour and habits of consumption which in turn related of course to how that consumption is provided which is related to design. To design something in a specific way to provide what customer wants or the service that the demand of the market. So, I would say that from the beginning the behaviour itself is an obstacle." "To convince people to a different behaviour is better. I would say first behaviour than all and the state of mind." "You have economical related issues that has any big change in society demands investments, demands resources, financial and others to shift." "You have to understand that you have to consume less, you have to change literally everyday habits. So, we are talking about literally every person on the planet. (…) It starts with behaviour and the first obstacle is to change the mindset." "You have industry of course. To change the way we produce things does demands a lot of investment and again also who produces to be convinced that it is a need to change the way. Parallel to this one of the biggest challenges in 21st century is exactly that. How can we produce the same with less impact? It implies that you have to change the production methods. "You really have to change the way of consumption. Even it is the first principle of sustainability. Just consume less. It is not recycling, reusing, reducing. The first one is to reduce. Recycling is the last one. And

	currently is the other way around. But it is way better not to have it in the first place if you don't need it. So, the first obstacle and the biggest for me is changing the way people consume."
E3	"Even though it is a great concept, it is really hard for people to internalize." "For my point of view, we as designers maybe not as researchers, we are neglecting sustainability a lot." "almost every single design school doesn't have sustainability as a pillar or core of a course. It might have subject in the chair, course inside the whole course like eco-design or design for sustainability. But I don't believe that it can solve the problem. I believe that every single subject at design schools need to have a bigger pillar on ethics, sustainability, social responsibility." "If you are discussing sustainability apart from the project, you might not embed that idea into designer's mind. They might not understand how the product they do, impact to either the environment or the society or the economy of their country. So for us to be more aware, I think we need to shift education." "To have that design we need to change education." "History. I guess. We have been doing things in a certain way. People used to do that and it works. We like it. We are spoiled by history." "Our habits, by our culture. And changing that means that you have to give up a lot. I understand that but I don't know if I am ready to give up everything that I have. Are you? Are you ready to give up your clothes and your phone? I don't know… It is not easy. It is very hard. Because you have been thought that it is a good thing to have a car, a big apartment, luxurious, to have a big TV, all the services, streaming, the latest phone…"
E4	"It is so systemic and so complex that is impossible approach all sides. It is impossible to be 100% sustainable." "I think it is the third parts." "For instance, as a researcher, I think it is very nice to work with people and involve them to think on the social aspects. However, as a practitioner, I found it very hard to work with a supplier on the contrary. Not just suppliers because you will always find someone wants to pay, that will do what you want but it will increase so much on your price. Even your most committed sustainable clients won't go in sustainable way."
E5	"I think all of us disregarding that (social pillar of sustainability). Not only we as citizens, our behaviours but also producers, designers. So, everyone, all the stakeholders at some point are disregarding, missing something." "I think the main one is the complexity." "It is very difficult to approach. There is no one answer to it, so there is no one solution. To try to implement sustainable development or sustainability we need several approaches so everyone should work together towards that." "There are many principles, steps that in some cases, the objectives are not quantifiable, in a sense that they don't have something… well if you don't implement them, you don't suffer anything." "Although the goals are defined there is nothing enforcement. This is on political level."

D. Expert Definitions for Sustainable Behaviour

Expert	Quotes
E1	Sustainable behaviour is to look at the products and have a notion of their lifecycle.
E2	For me a sustainable behaviour is the behaviour which people are aware that their personal choices have a certain impact. They are able to measure somehow that impact is minimized or at least have a way to return that impact by just choosing things that are better designed, last longer, choose to consume less, consume what you need.
E3	I don't know. The reason why I don't know is that everything is very complex like I have just said. Every decision that you are making whole bunch of little decisions, you may go to Celeiro (Portuguese health food store) to buy an organic food. But for instance, let's say that the lighting that they are using there doesn't come from renewable sources. Ok, I am buying organic but there is a whole bunch of other things, how about the people work in there? Are they being treated, being paid enough? Because sustainability is also about people.
E4	Sustainable behaviour means that you have to do such an effort. It shouldn't be like this. Solutions should come step by step to you and help you to improve your daily behaviour.
E5	It is related to the impact of that behaviour. If you have a behaviour that cause a negative environmental and social impact, it is not a sustainable behaviour. I don't believe in fully sustainable behaviour and also fully sustainable product. It is roughly the same thing as we were talking about sustainability. Something we cannot achieve, here is the same. There is always some sort of impact when you develop an action or product. You can reduce that impact but it will always be there something. So, the correct phrase or expression should be "more sustainable behaviour", in my opinion.

E. Asserted Examples of Sustainable Behaviour by Experts

Expert	Quotes
E1	Don't waste a water or energy at home
	Make separation at home, recycle materials at home
	Consume less resources
	Electric mobility
E2	You have an information about what is better regarding to another thing
	When you want to buy something, you choose based on information. This case, if you just do this exercise "Do I really need this?", it will be really simple. You just stop and think a bit, breathe, "Do I really need this?", "Do I need a second thing?" or "Do I really need to go there or spend this or that?"
	The second thing would be "Ok, I am going to buy a new pair of jeans, so what do I have to consider?". First, materials, where is produced, how are the conditions of labour. If it is very far, if it is local because of transportation of the goods.
	Is the brand responsible in the sense that they give those conditions, how do they marketing, do I see myself in their philosophy as a company?
	Organic farming
	Producing locally
	Lower your carbon foot print by producing some water or food.
	Again information, again knowledge.
E3	Buy an organic food
	Understand that we don't need everything that we have
	Choosing or trying to be more informed about what you are buying,
	Trying to avoid the urge of "I need everything" all the time
	How you go from one place to another, sharing more. I think sharing has a big part of sustainability as well.
	Better use the sun and solar panels.
	Take public transportation
	Bike sharing is a good thing, good for health and environment
	City farming on top of the buildings
E4	Having a conscious
	I disconnect the lights, unplugged all the office suppliers before I go
	To be aware of the information, the little things that they can do.
	It deeply hurts me to buy these t-shirts that are being done by children in somewhere. I take my daughter and I prefer to buy a t-shirt that is 10 euros and make sure that is properly made.

	Knowing the impact, knowing what you really do Take an electric bicycle or just walk. Using public transports
E5	If you walk, ride a bicycle or use public transportation the impact is far better than the electrical one 3R policy: Reduce, reuse, recycle. Nowadays we think that we need to recycle and recycle. But that is not the order of the situation. We need to reduce and if we cannot reduce, then step 2 is reuse. Only in the end if these two possibilities are not available, then we recycle. Reduce the amount of the material in the objects Reduce the need of buying something, thinking if we can do it another way.

F. Expert Quotes for Obstacles to Sustainable Behaviour

Expert	Quotes
E1	usually, and that is not true but usually, sustainable products are more expensive. And the consumer just believes that being more sustainable is more expensive there is a gap between what consumers do and what consumers say. there is also some kind of mistakes in the perception of users. Sometimes people think that they have a sustainable behaviour. In fact, their behaviour is not so sustainable. And then you have another thing is important to consider. When you have more sustainable behaviour in some cases, the overall consumption is higher. For example, imagine a home with normal lamps and they consume x amount of energy, they want to be more sustainable and they changed to LAD light. So, the consumption ideally will reduce a lot. But in practice, in most of the cases that doesn't happen because they have the notion that since they are using LAD light, they can have the lights on much more time. The problem is when you change the consumption habits, you buy sustainable products. But if you use more often the product, the sustainable benefits sometimes are not visible. Nowadays in the city you have a lot of scooters. That is good in the way that you have electric mobility available all over the city but what in the end happens is that some of the people that are using was walking before. They were doing exercise, and they were not wasting energy because they are electric and the consumption is something. So, you are not solving the problem. We are trying to solve the problem, give more possibilities for users but we have some drawbacks. I think that our society is not sustainable at all. Our nature is not to be sustainable. The change is in being sustainable. If people don't have money to buy stuff, they don't consume, they don't produce waste. But consider that people have more money, they will consume more, they will buy more. Money is the trigger.
E2	I would consider that to be obstacle/objective to fulfill is, how you can make people definitely aware of their true impact of their choices. It is also a huge challenge and not just produce something more sustainable or to has less impact but how you can inform people of that change or better performance. have a way to present that complex information in a very straightforward way, very easy way. it is a behaviour and you cannot force people to opt. You have to let them choose. In parallel you also have education which is paramount. And you have to work with kids, it is a best way. If you consider generations, you have to start with the generation where it is easier. Kids are much more easier to convey good practices. As we get older, we start to deform our minds to convey to some aspects of society. Price is great constrain in sustainability. If people demand better, it would be a lot easier to do better things and produce better or invest money and other aspects of society that will contribute to a broader or real definition of sustainability, sustainable society. That would be for me a sustainable behaviour when you do that homework. For me that is homework. You are just doing your homework before you consume. Again, this is the tricky part because most of the people will say that they really don't have time to do that or would say they have time. If you have to supply something in a huge amount, if you are still using very primitive ways to produce things, so that means that the only way to ramp up the extraction. In terms of social responsibility, it means that people will be explored normally, because you want to maximize profits so you will cut costs where you can do it is always labor. Labor environment in the sense that you don't necessarily follow the rules that are put being implemented. Again, it brings us knowing something and then being able to consciously choose. When you don't have a lot of money and you have to eat, of course you just want to eat. You don't care where things come from which is totally acceptable. Organic in itself is not going to work obviously because organic is what we did. I mean initial farming was

	organic. We just put the seeds in the ground, it went up and done. You don't put a lot of things into the system to produce, so energy rises very low. But again, if things scale up, you need more so that process does not fit currently. It makes sense in some aspects definitely because it has to do with regulation, it has to do the way that you produce massive things. You are trying to test new practices that will guarantee that some abuse in chemicals are more regulated. people have all the reasons in the world, some more objective like "I don't have money", "I have 5 kids to feed". These are very objective reasons to be more sustainable or at least not have more impact by choices of consumption. That is tricky because you can easily start judging people almost in a moral bases which is stupid, doesn't make sense. Things should be fact-based always. I am just saying that it is very easy when you start to ask that why people are having unsustainable behaviours, it is very easy to go that road of morals and demonize people for their behaviours. People are a bit selfish I would say. I am saying this just by saying that we shouldn't be moralize and so forth. It could be almost understood as that. But it is true that individualism which is something explored, I don't want to be seem repeating myself but the way we behave as a consumer, it is related to our individualism. I think it is after renaissance when man is put on the center. I think it started there, to be honest. And after that, society started to be more and more individual at that aspect. people are not sustainable because they are not looking at the big picture.
E3	I don't know. The reason why I don't know is that everything is very complex like I have just said. Every decision that you are making whole bunch of little decisions, you may go to Celeiro (Portuguese health food store) to buy an organic food. But for instance, let's say that the lighting that they are using there doesn't come from renewable sources. Ok, I am buying organic but there is a whole bunch of other things, how about the people work in there? Are they being treated, being paid enough? Because sustainability is also about people. I think we are trying to figure it out because we built such a complex society but we cannot just start over. they learned to live like that. It is just natural to them, it is easy. It is just the way it is. Being sustainable is the opposite of what we have learned. The excuse isn't about not being sustainable. It is about being sustainable. Why do I need to be sustainable? Because everything else is teaching us otherwise. It is very comforting to have everything on your head to push an app and have someone deliver food to your house, not cooking at your home, that is very easy. Why should be people sustainable when it is so easy not to be?
E4	When my peers do something that I don't, then it bothers people. Again, the electric cars. They are also a problem because of the batteries. Technology is changing constantly so that the features are changing and you can't stop renewing with a better one. I think it is easier, cheaper. Not knowing the difference.
E5	We are always talking about electrical vehicles. Although the product itself has more impact on the environment than the non-electrical one. Because of the batteries, mainly. We are thinking about electrical vehicles and change the paradigm but maybe it is not the best solution. We are all surrounded by material culture. Everything is designed, produced and has an impact. When we are using them, we have already been causing impact. Because we don't care. We think that it is not my problem, I didn't create this. I want to live my life as I want. Everything is ok so why should I bother or change my behaviour? if you as a producer or designer present some solution that is interesting or affordable, they will probably opt for that. But they need to know what they are doing. So they need information to make the correct choice.

G. Expert Quotes Tagged as "Fashion", "Technology" and "Fashionable Wearable" as a Barrier Breaker

Expert	Quotes tagged as "Fashion as a barrier breaker"
E1	Yes, I think it can overcome. The production has high impacts, the overall consumption of the materials is huge. And the behaviour of people concerning fashion is to consume and consume. We don't buy clothes to live, but to show. everyone wants to look different everyday. the clothes that you sell this year are different the clothes that will be sold next year. You have this notion of the latest edition of clothes and new arrivals.
E2	It could definitely help. Because fashion industry has a lot of carbon footprint or instance. If you could change the perspective of that industry could definitely help a lot. fashion is related to a life style the way you present yourself to the world. So, it has that huge impact, huge impact on how we perceive ourselves and how other people perceive us. So yes, definitely. you are able to present them in a very fashionable way, I think you can definitely educate people. being fashion very powerful that permeates a lot of aspects of our life so definitely you could influence in a positive way Imagine that you are able to devise a strategy that it is cool to be something that is more conscious, that is cool to make those choices. If those choices are visible and when I say visible, you could think social media, social networking, all those very fast disseminating platforms definitely could be used as a way to change people's behaviour. It could almost be like a game. That could be a way but again, how you deal with is difficult. Look at fashion; how fashion communicates, permeates society and try to see mechanisms that the use to convince people to do something to wear something. You could try to use that knowledge to your benefit; to change behaviour to something more sustainable.
E3	I think so. I don't know how but first of all, we need to stop the idea that every single company has to grow and keep growing until it explodes. That is what happens in fashion as well. Do people really need a new collection every two weeks? People really need to feel that they are not really using the latest thing they have. So that is everybody's turn to look beautiful, to make a name on themselves, to have an identity and being part of something, making a statement, right? But it is too fast. Because every time we do something new, you feel like whatever you have is old. And it is a terrible feeling. It is like a competition; it is shallow but we like it. I think fashion can overcome that. It needs to shift the business model from selling product to sell a service that sells that this shirt is going to last forever and I can provide something else to you so that lasts forever. So, bring this every time it loses a button or the color is fading, we can fix it for you.
E4	In the 50s, many clothes were handmade, they all look so fashionable. Why now we dress from these end-market brands and look so horrible? The way we upgrade fashion patterns for the different sizes, it is not made well so it doesn't fit well anymore. Why? Zara want it to be. Because if you see it first, you like it, you buy it, then you go home, wore it 3 times and you don't like it anymore, so you throw it away.
E5	Human behaviour is very sensitive to appearances. We live in a society with very fast-based and fashion is one of the areas that mark with it. In one year, you have 2 sets of clothes, all is coming and going. We are aware of what we interest what kind of things that the rest represents, how we represent ourselves to others. So in that sense, it is a very huge deal how can we change that peace of material of interest. In a way that it

	changes our behaviour. It is also one of the very difficult areas, because it is probably the fastest one.

Expert	Quotes tagged as "Technology as a barrier breaker"
E1	With technology, you can focus on the changes, the adaptability, the customization. So, you can in a way reduce the consumption of resources by focusing on technology. Maybe, yes. Can be a way.
E2	Technology is a tool. I only see as that not the angle in itself, but a tool. I was talking about social media; it is impossible without technology.
E3	It is the same. Technology has taken the same path as fashion. Every brand needs to unravel a new product every year, every six months so it won't look like. They are losing their competitiveness and so that stakeholders are happy with the results and the sales.
E4	I think we will go to the path that we put all these sensors in clothes, tell us the humidity, temperature and things. But I think it will be like the electric cars. Then we have sensors, then how we will recycle the sensors, then we have more sensors and batteries. I think I prefer the old t-shirts.
E5	I think technology has proven in the past that can change human behaviour. We can see in the gadgets, I-phones, and other things. The society has changed completely. Few years back, you see group of friends that are talking each other, now you see the same group and they are all looking at phones and touching it. It is just an example. If it is possible to do that, in the sense of normal behaviour, that is possible towards a sustainable one.

Expert	Quotes tagged as "Fashionable wearable as a barrier breaker"
E1	Yes. It might be expensive. But it depends on the solutions. Let's imagine you develop a special wearable that can change the color everyday, or can change the look, texture, yes it will be more expensive. But in the end, you don't buy other products. Maybe. You have huge straight-offs. You have to think on the benefits and what might change.
E2	If that enables you to have access to information in real time in a very easy way about your choices, yes. Definitely.
E3	I never have a deep relationship with wearables. I wore a Fitbit (activity tracker) for a while which was good. It was fun, my steps were tracked down, how long have been exercising… Anyway, so I think it was a good thing. The experience was awesome. It was good to see and try to establish goals for my days, I am going to walk this much, try to walk 5 sets of stairs or 10000 steps or do at least 30 minutes of exercise. It can. Fitbit has a good gamification kind of thing. Every time you accomplish something, they send you an email like "you just do this and that…". Motivate you to do more and to what is going to be next. And we see that Nike has some cool apps to help you keep running and train. So, I think wearables are pretty good to be healthier. I don't know if sustainable but healthy.
E4	Not that I can see of it. But if you tell me, if it's for health reasons, then of course I would approve. I will find it interesting and even cool. If a t-shirt tells me if my blood sugar is low, if my heart beating causes a risk, if I need to calm down or take pills, this is nice. So, yes if it is a health issue that is vital and makes my life easier. But not as a gadget or plugs, not for me. We should go simple.
E5	It can help. Those kinds of products are not sustainable. Like electric car. Something like... Because you have another gadget with electronic, chemicals and rare metals that come from Africa or wherever and the battery issue and so on... But it can change our behaviour. So, throughout its lifecycle, it can have significant positive impact.

H. Expert Quotes for The Discussion of The Research Question

Expert	Quotes
E1	Hard question. It depends on the level of technology but you can. For example, if you develop 3D process to print your fashion artifacts at home, it can be an innovation. You can reduce production in other countries and avoid a lot of transport. Then, it will be so easy for people to have new products every day, they will consume more. They will produce more. So, you have to have a balance between the technological solutions and the consumption. Of course, you can have a technology in clothes to minimize wash, you can have technical materials that have some self-cleaning properties that you don't need to wash. But if you have these kinds of products, you have to make sure that people will change behaviour. It is a tricky question. I think the most difficult thing in sustainability is to change behaviours. We have 2 options. One is force people to change, and that it is not working, or you can think about ways to add value for the users. If you add value in the direction of turn them in a more sustainable way, it will work. If you want to change consumer, you need to make sure that they benefit with it. By themselves, they don't change, if it will be harder for them, if they will need to change without knowing why or without having clear benefits, it won't work.
E2	option of consumption and you are buying something that informs you, just give you the information. If that is something on a jacket or any clothing or something just that as you said jewellery that could just whisper you something almost like a demon or an angel. Buy this, buy that. No, I am kidding. But it can give you information by just sending somewhere, some place. It is not like I buy a t-shirt and the t-shirt is always talking to me. No, it is not the idea. It is something that you understand that is embedded, understand that you want to have that information. For instance, you have feeds on your cell phone. You have some specific feeds because you choose to have them. That is why technology and behaviour change is not apart from education. You have to be willing to participate. The problem for me is always the same, how you will convey that information to people in a very straightforward way. don't be judgmental, don't judge people. Nobody likes to be judged. Don't force information, of course it has to be something that people are willing to accept. In terms of product, be careful how you integrate things. When you start to fuse different technology, you have to consider the lifecycle of the product, how it will end and separation of electronics in fabrics can be something that is complicated. So, it depends a lot on how things mesh up or fuse which tends me to think about this in a more modular way. Something that is not necessarily dependent. It is wearable because you can put next to your body but I don't think it should be wearable in the sense that is embedded in every clothes. It is something that you just put on. So yes, jewellery is a good example of that. Because you do not throw jewellery when you change your shirt. this technology harnesses the power of the phone and the wearable in itself almost like a peripheral like a phone or something that you just add on. You are making it cheap and probably low energy to produce which is a good thing and you can reuse it. It is not dependent on the clothes. Of course, it is dependent on the style of the fashion. To promote that you could go further and you can have that is just a system. I would try to do something that is not fuse to the clothes in itself. It could be just a pocket.
E3	Instead of only saying you should catch a bus, it might say think about leaving earlier and just walk there. It will take 40 minutes. Or even track your meals and also suggest try eating healthier or better. I think it is good to have that kind of melting in your head and helping you develop better habits, more sustainable habits for instance. It is pretty annoying all the buzzing and all that. But we also kind of used to it, don't we? How many notifications do we get on our phones every time? I think it is better to have that on a wearable than have it on your phone. Because every time you take your phone, you kind of loose yourself in that screen. So "I was supposed to check something, what was it? I don't remember anymore because I have just accessed to Facebook or want to see article and suddenly, I didn't call whoever I had to call or I just didn't leave home.

	It is good to have notifications but I think in the smaller amount and it is very limited. I don't think a wearable should replace your phone. I don't like the idea of implying to tech on your watch, sending the message and something like that. It is just replacement and there should be a separation. It should be different. Don't make something so that people buy it because it is cool but it is useful. Be careful with information that you are going to gather with this device, how we are going to use them.
E4	You might have an interactive tag that tells you what it has been made, by who, from which sources. You can also find it in a paper of label with a QR code. You can have a rate now like we have it on supermarkets like Continente, they have a code on food that tells about ingredients. In clothes' case it might say you it is made with cotton or not, and supervise suppliers if it is children work. If it would give me information yes, if it will be for health, yes. If it really gives you something important, data that is important for you to choose or understand. Well, it is hard and very challenging, so congratulations on that. I think you should think what is sustainable, it is the cloth, it is the item itself or it is the information that you are giving, and therefore you are working on the behaviour. It is hard to work on everything. Are you working on the expectation of people such as if they are informed well, they will change, or are you working on the technology on clothes that will be sustainable? If I were you, I would work on a line of clothes that can be sustainable.
E5	some people who become aware, they try to change behaviour, but most of the time it is not a permanent change. So, it has to be an easy thing to do. It has to be a change that we do naturally. Only a small percentage of people by their will, the others will not. So it has to be something that probably without them being aware of. You can change unconscious part of ourselves. If it is something that you are demanding from us to do a conscious change, then that has some kind of effort. What kind of information that gadget gives us that will help us improve our daily routine, to know when the bus is coming, you need to find a specific area. Because like I said, sustainability is so large and very wide. In a specific area of activity, if something is used in the house, something medical or for nurse… I think you should identify the main impacts of our daily life and try to choose one or several, the ones are related or addresses the same thing. Either use of energy or the kind of things that we eat... The mobility, now the chemicals we use, tooth brush, tooth paste, detergents. If you identify that the main impacts, and came from where, from what kind of behaviours/actions originate those impacts. For instance, main problem is climate change. It is related how our behaviour and use of energy. You need to identify what we do as a society and as a person that originate the problems.

I. Focus Group Participant's Demographic Form

Thank you for participating in our research!
First, some facts about you. Please fill all the areas below.

YEAR OF BIRTH	……
NATIONALITY	……
GENDER	☐ Female ☐ Male
PROFESSIONAL STATUS	☐ Student (Field:……..) ☐ Employed (Job title:……) ☐ Unemployed ☐ Self-employed (Job title:……)
EDUCATION	☐ High school ☐ Bachelor's degree ☐ Master's degree ☐ PhD
WHERE DO YOU LIVE IN LISBON?	Neighbourhood: ……..
CIVIL STATUS	☐ Married or cohabiting with another person ☐ Single
DO YOU HAVE CHILDREN?	☐ Yes ☐ No
HOUSEHOLD INCOME (INDIVIDUAL INCOME IF SINGLE)	☐ Less than 10,000€ ☐ 10,000€ - 24,000€ ☐ 25,000€ - 39,000€ ☐ 40,000€ - 54,000€ ☐ 55,000€ or more

J. Focus Group Transcript Based on Problem Topics

T	F	Tagged Quotes
Security/trust	68	F1. In Brazil, we have these (gender separation) on metro but because of harassment. F1. I think security is also important. F1. Yes. F1. True. F1. Yes, I saw many times in the bus, people are falling because of the way of driver drives. F1. (Confirm laugh) F1. For me, everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. I know that rape and harassment are not as common as in Rio here, but still, I would never take these options in any circumstances. F1. If I had the money to buy a car and I bought a car, I wouldn't like to share with other people because they might damage. It's the hygiene issue and security. F1. Security problem. F1. If you know who's coming the next day with you, and I'm going to accept or decline the person. So, I don't think it's bad. F1. I can share with people that I know, that's okay but if I have to share with strangers, I wouldn't do that. F1. I would like to share with our people but in the reality I, I came from a country that is not safe even to say hi to people on the street. This is a texture that for me it's really relevant I have to be prejudice. F1. I don't prefer to walk at nights. F1. I know the percentage of error is really small comparing to people but I can't trust a machine, you know. F1. I'm a bit pessimistic about autonomous cars. I trust more when people driving. F2. I am kind of afraid of car sharing, I can crush a car that's not mine. F2. Using Uber as a woman alone is also dangerous in Brazil, for instance. F2. Yes. I mostly share my locations with my friend or family when I was in Taxi. F2. If I know people I would share. F2. Maybe. F2. The idea to have a driver that he can pick you up. But you have to share with other people that you don't know and I find it very weird. F3. For me, the only reason why I won't choose autonomous vehicles that I'm scared that something might go wrong. So public transportation is my choice, I mean, there's a possibility that I'll crash there, but at least I'll have somebody to follow. F3. Also imagine that you go to work by bike every day and one day you woke up and there is no bike. F3. And then you will be kind of stuck with the bike. Where am I going to put it (bike) and you'll be charging. F3. Close friend or a colleague. F3. Honestly, I wouldn't mind coming by bike, but it's sharing. F3. You can use ride-sharing for short trips but for long trips, it might be tricky. F3. You can share the car with colleagues. F3. Yeah, exactly. F3. I don't like other people knowing where I am and when I am in somewhere exactly. I like my privacy. F3. No maintenance for bikes. F3. No. F3. The whole thing that being your data tracked and everything, I don't want them F3. To be honest, anything that is shared with bikes or scooters, I do not like. There's no monitoring there is no regulations, there's no maintenance. You don't know if they are working properly. F3. To share the car with people you don't know… F4. It depends. I mean as a woman I wouldn't prefer it. F4. I feel like public transport especially for a woman is a bit vulnerable in certain situations. I wouldn't like even if it's cheaper or eco-friendly, sharing is tricky. F4. When the metro is all packed, some can easily steal your phone and take advantage of the crowd. F4. It's a huge problem. F4. Sometimes I have expensive things in my backpack, laptop or my camera for instance. I don't want to go with a bicycle that I'm so vulnerable to falling or something. I think there are some situations that you don't want to ride a bike. F4. We have a lot of hills and you have to go up a lot so it's not really suitable and dangerous. F4. I don't feel safe in Uber. Sometimes because of the driver and sometimes because of the payment method. Sometimes they take me from the long distance. F4. In my country, people use their cars because public transport is not reliable and decent. F4. Sharing with friends it's cool but sharing others, no. F4. There are mean people outside.

		F5. In Brazil you don’t feel secure when you take a bus or metro. F5. I hate scooters I think it’s not safe. F5. You don’t have a helmet and you can be in the middle of the cars so it’s dangerous. No one is walking with the helmet. F5. Everything related with sharing is tricky. I don’t know, you go with people you don’t know, how might they behave… F5. I don't mind like sharing with people that I know F5. It is a bit security issue. I don’t want stranger in my car. F6. Drivers don’t respect bikers. F6. The scooters are awful, they are everywhere and very dangerous. I fell one time. F6. It’s not secure and inconvenient. Also, expensive. F6. Some people leave the scooters in very dangerous places that cause trouble. F6. As for instance, we are girls and there are so creepy guys (in bus/metro). F6. Yes. F6. (Nods) F6. That's another problem with crowd that is sometimes cause harassment. F6. I don’t feel safe while riding a bike. People, drivers can crush easily. F6. If there were bike roads, I might have felt safer. F6. Drivers don’t like bikes on the road, they hate it. F6. Even with a random car, you get to know the car, the engine, to drive. F6. I was late today because they decided not to make that schedule and it happens a lot. F6. I'll be afraid if they crashed my car, even they are my friends. F6. It's kind of hard to feel secure in someone else’s car. F6. No way. F6. There’s no way.
Time	65	F1. You never know when it will arrive. For that reason, most of the people use cars. That is not good because this causes traffic jam. F1. I think punctuality. In Brazil, we don't have that. F1. There are applications that show the time and it's always correct. F1. Not really. F1. Here is not F1. There’s an app for the buses but lots of the time they're not correct. F1. I use it every day, the apps are accurate a lot of the time and then sometimes it just doesn’t work. Or it says five minutes. You wait five minutes, and then bus appears, you realize that thirty minutes passed. F1. Five minutes is like ten minutes. F1. The problem is the lateness and not knowing when. F1. The problem nowadays is that I know the bus will come in 20 minutes but I don't know when exactly. F1. (nods) F1. (nods) F1. I think it’s punctuality, frequency. F1. I think frequency is very important because in my case, I had to take bus and then train. If the bus doesn't come, I had to wait an hour for the train. F1. I hate changing transportation. F1. I think it (multi-modal transport) may be if it works properly, we don't mind to use it more often. F1. Every day I wait for the bus and then the metro and then switch to other metro line. It's a lot of waiting time. And that's why it's frustrating. F1. Now I walk more because I prefer to walk rather than wait for a bus for 20 minutes. F1. They have electric buses and what is really good for the environment. But the problem is that they are very slow. F1. I think the car is useful for if you go out at night for example, to the areas that don't have a lot of transport or long distance trips. F2. The worst part is not the time but the quality of transportation. There are some lines of the metro that it's super crowded and you have to wait for other cars and it’s too bad. F2. Traffic is really bad and every distance is more than one hour. F2. I think public transport is very slow in here. I can wait for a tram for an hour. And subway is in every 15 minutes. Frequency is not enough for the amount of people. F2. Yes. During night F2. (Nods) F2. I work in Carnaxide and to get there is terrible. With car it’s 15 minutes but by bus it’s 1,5 hour. If my car breaks down, I’ll cry. F2. The most important thing is to be on time. F2. Sometimes you never know when the bus will come. So if I’m going somewhere in near distance, I always check Uber how much does it cost. If it is low cost, I prefer Uber. F2. I don’t want to wait 40 minutes, I'm not gonna be here (bus stop) forever. F2. What works for me is the car. Because I work somewhere that public transportation is really bad, the car makes it really faster, more comfortable although it’s a bit more expensive. F2. I hate taking the metro and changing the line. Taking bus and then metro is worse.

F2. The problem is the time you lose between the two transport. I feel like I wait more than direct transport but maybe it's psychologically.
F2. One hour or two hours for mobility, I need that time.
F2. I used to be more comfortable going out by car at nights. Going out without a car is too much work for me. It's easier for me to leave whenever I want.
F3. Schedules are better here in Lisbon. There are more options also.
F3. I use my car because I do like the comfort. Also, the main reason is to go to work it takes 45 minutes to 1 hour but with car it's 10 minutes.
F3. For me it's the opposite. Private cars take longer especially during the rush hours.
F3. If I could and I have the money, I would choose autonomous vehicles. It's a good combination of what I like in public transportation. And it would also make my ride shorter. By train and metro one and a half hour to get here. By car it takes 20 minutes or less.
F3. Timing.
F3. I like my comfort, the best time so I would like to go from point A to B in fastest time.
F3. Multi modal transportation is the least preferred one. You lose a lot of time during the changes.
F3. That's horrible.
F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes.
F3. I still prefer to have a personal bike, walk and my car. I mean it can sound a bit selfish but I like to have my own schedule my own approach.
F3. As long as I know how long it's going to take between all three (multimodal), I always get there on time or even before time. So, I don't mind multiple transportation.
F3. The only thing that I don't like about a personal car is the fact that everybody has it and then there's rush hour and then you're waiting for a long time. And no, I hate waiting.
F3. It takes 30 minutes if you are passing the bridge in rush hours, not 10 minutes. But it's still faster than public transportation.
F3. I think it would be better to have everything free, everything open and have more people doing the job instead of the gates. Every time I go into metro, I need to wait for the queue to charge my card.
F3. Maybe sometimes it's a little bit related with mobility. But it's not because I don't have a car. It's just because I feel lazy to spend time to go somewhere just to have fun.
F4. In my country, people use their cars because public transport is not reliable and decent.
F4. When I use bus, it takes 2 hours sometimes.
F4. I have to combine transports every day and it's really annoying. If we miss one bus, we have to wait for an hour for the next one.
F5. But in Lisbon the Carris app says the bus will come in 10 minutes, but actually comes in 30 minutes.
F5. I agree with that timing.
F5. It's difficult to know when the bus is coming, it can be more efficient.
F5. Timing is important.
F5. Yes.
F5. Sometimes I carry my skateboard around but just to save up 7 minutes of walking.
F5. Big issue about walking is the time that it takes.
F5. You need to download, put your card number, then discover how the thing works
F5. Yes. It takes time.
F5. You can call uber for emergency. I don't agree.
F5. Sometimes uber takes a lot of time to come. You need a car.
F5. I live in Cascais and the last train is at midnight so sometimes when we go out, I have to sleep at my friend's house which is not very satisfying.
F6. Timing.
F6. When there's an emergency, I think sometimes you need your own car. If I really need to go somewhere quicker, I think I would call for Uber.

Demand additional ...

56 F1. If the distance is short, bikes are good. It's not suitable for all clothes and also if we have to carry some stuff (bike).
F1. Yes
F1. Yes.
F1. We as designers need to carry lots of stuff all the time. That's an issue of course.
F1. I agree. In Dubai, I had to cycle from my house to school. Because of the weather, I usually went fast. I always went to the classes full of sweat.
F1. I have to catch bus and the metro. Unless I have pockets in my jacket, I always carry the pass on my hand.
F1. It is really boring because you have to take it (jacket) off and put on and take off again if you're changing transport.
F1. I agree that there are lots of scooter brands and I'm lazy to download the apps
F1. I agree.
F2. I totally agree.
F2. Agree.
F2. I agree.
F2. There are too many scooter brands.

		F2. Once I decided to go work by bike. I tried 3 times and then I gave up. Sometimes things happen like, today I want to wear skirt, today I want to wear sandals… F2. I need to stop at supermarket, I cannot take the bike. F2. One day it's raining a lot and the other day it's sunny but there's one percentage of chance of rain, then ok no bike. F2. I put my card in the pocket or purse F3. That's actually correct. F3. Yeah, that's, that's exactly I feel about it. Even if I would want to try one, I never did because you install an app. And then you get somewhere and there's a different brand. F3. Yes. F3. Yes. F3. Exactly. F3. Yes. You know, workplaces are not suitable and don't have facilities like shower. F3. I could bike from home to work. It's 10 km but how smelly I would get when I go there? F3. If I have a room or locker to put clothes or stuffing, a shower, maybe I would consider. F3. And also, we need places to leave your clothes. Because you know, coming to work on a bike you have to wear very comfortable clothing. Sneakers, shoes, shorts, t shirts. Usually a very thin long sleeve. Sometimes you have meetings where you have to dress up so you'd have to have a place where you can put your clothes. F3. I would still prefer a lot of locker rather than carrying in my backpack. F3. I think it would be better to have everything free, everything open and have more people doing the job instead of the gates. Every time I go into metro, I need to wait for the queue to charge my card. F4. I agree that having too many brands causes confusion. I don't have the time to actually research and stuff. F4. Sometimes I have expensive things in my backpack, laptop or my camera for instance. I don't want to go with a bicycle that I'm so vulnerable to falling or something. I think there are some situations that you don't want to ride a bike. F4. I put my transportation card back of my phone. F4. This is true. I often think like that. F4. When I have groceries with you in the bus it's the worst. If I cannot carry it on myself, I just call Uber. F5. If you don't have a card, you can pay to the driver but there must be a system that you should be able to pay with your credit card directly inside. F5. Buying a separate ticket for the transport can be replaced. F5. I already pay for the public transport, why am I going to pay for bikes or scooters additionally? F5. I've never use bike-sharing or scooter-sharing because I'm not that athlete. F5. You don't have helmet and you can be in the middle of the cars so it's dangerous. No one is walking with the helmet. F5. I don't understand how can people go to a meeting with cycling and arrive at a meeting with clean not sweaty. F5. Clothing can be an issue while biking. F5. When I tried this one time, I came to school very sweaty and I don't like it. F5. I don't want to change my clothes, to carry other clothes and change it. It is too hard. F5. Yes. F5. If I could use the same card for public transport with bikes, I would use it. F5. If it was included, I would use it definitely. F5. Totally agree. F5. I'm always with my phone and pass in my pocket so I need to say something or use, it's easy. F6. The scooters are awful, they are everywhere and very dangerous. I fell one time. F6. Yes, that's one of the reasons. F6. I don't know I just cannot balance on them. F6. I go to university with my computer and lots of stuff, I can't ride a bike with them. F6. A rain coat can solve the problem, but I still prefer to walk. F6. The weather needs to be good for biking. F6. This is so me. F6. When you have a backpack it's hard to arrange things on gates. F6. Sometimes I just want a green line, without using transportation cards, validation on gates or buses. It would be so good.
Cost	46	F1. Of course, I would want the personal car, but I don't have. Not only because I don't have the money for that but for parking issue. F1. Parking is starting to be very expensive in Lisbon and the prices are getting higher. F1. It'll be great but it also depends on the price. If they had some kind of system like the public transport which you pay monthly and a lot cheaper, I would definitely use. F1. Yes, yes. F1. This one is way more expensive one pay in one trip here. F1. this already happened to many people that I know because sometimes we have to disconnect but they forget to turn it off. F1. They don't want to have the trouble of downloading and understand and know. F1. If I don't pay for parking I would use car all the time. F1. I agree. I use these excuses to not go like oh, I can go. We don't have Metro, I can't go back home by Uber because I don't have money. F2. Sometimes you never know when the bus will come. So if I'm going somewhere in near distance, I always check Uber how

		much does it cost. If it is low cost, I prefer Uber. F2. Mobility price must be convenient. F2. What works for me is the car. Because I work somewhere that public transportation is really bad, the car makes it really faster, more comfortable although it's a bit more expensive. F2. Sometimes it (scooter) can get more expensive than picking on-demand transport. F2. Scooters are really expensive. F3. If I could and I have the money, I would choose autonomous vehicles. F3. I'm not satisfied with cars. Because it costs. Gasoline, car maintenance. F3. I don't have a personal car because I don't want to stress and I don't want to pay expenses. F3. Rental car is really cost a lot. F3. Yes, they are expensive. F3. If autonomous car existed, it would be very expensive. F3. Scooter is very expensive F3. I believe this guy didn't try it because it's expensive. F3. And then you will be kind of stuck with the bike. Where am I going to put it and you'll be charging. F3. You also have to be stressed about finding a place to put your cart and again, it's the cost of parking the car, then it's the insurance. F4. I pay 40 euros for month, it's quite expensive actually. F4. Price level is expensive in Madeira and it's not worth it. F4. What do you think? I think public transportation should be almost free or free. Transportation is a right to everyone. F4. Price is important. F4. My family have car but it's always a mess because of the parking in everywhere. Either you pay for everything or the one you don't need to pay are far. F4. If scooters were free, I would choose scooter. F4. Bikes should be free. F4. It doesn't make sense to me that there are zones and the price is changing. I can't afford to live in the center and I have to pay more than the people who can afford to live in center. With one ticket and you should go everywhere. F4. Yes. This is for everything if it's money I double check. F5. Cheap. F5. I already pay for the public transport, why am I going to pay for bikes or scooters additionally? F5. I's expensive also. I have to look for a place to park, parking is expensive. F5. When we have more money, we might want to be more comfortable and may want to use car. F5. I wish I had money to use. You don't need to drive, you can look at your phone or read. F5. Money is important. F5. If I could use the same card for public transport with bikes, I would use it. F5. If it was included, I would use it definitely. F6. Autonomous cars are cool but it's expensive. F6. I used bike-sharing sometimes with my family. It's not that expensive. F6. By walking you don't have to pay anything. F6. If it becomes cheaper, I would prefer autonomous. F6. It's not secure and inconvenient. Also, expensive.
People density/no space	42	F1. Sometimes it gets really crowded and there's no space to sit. Space is important. F1. Yes. F1. (Nod) F1. Where to sit, F1. Agreed all. F1. Rush hours are very very crowded. I have to stand and I am small so I travel with armpits around me. F1. I totally agree. F2. The worst part is not the time but the quality of transportation. There are some lines of the metro that it's super crowded and you have to wait for other cars and it's too bad. F2. Between 6pm and 7pm trains are also very crowded. F2. I agree. F2. Kind of agree. F2. It's so full that you cannot even get inside. (bus) F2. Yes. F2. (Nods) F2. In the rush hours the metro is so crowded F3. People should be able to sit. F3. I agree with. F3. Yes me too. F3. I agree F3. (Nods) F3. It also smells. A lot of them come from the gym I don't know where they are going.

		F3. The anxiety when you need to get out of a public transport, but you cannot because of people. It is too crowded so you have to crash people or push people. F3. I think it would be better to have everything free, everything open and have more people doing the job instead of the gates. Every time I go into metro, I need to wait for the queue to charge my card. F4. Metro gets very full between 6pm and 7pm F4. I hate it. F4. When the metro is all packed, some can easily steal your phone and take advantage of the crowd. F4. It's a huge problem. F5. Space is important. F5. Yes, everything. F5. It's exhausting. F5. You can not see, you cannot breathe. F5. Heat. F5. There was one time I almost faint. F6. Sometimes it is crazy inside of the buses because of the air conditioning. F6. In the morning like really like seven o'clock, there's a lot of people in the train. It's packed but 10 o'clock more relaxed. F6. In trains, some lines are more crowded than others. Some trains have two floors so it's better and more comfortable. You can sit. F6. I need to breath. F6. In the summer it's terrible. F6. Bus is not always great because it is crowded and uncomfortable, there is no place to sit, you just stand up and it shakes a lot. F6. Yes. F6. I agree. F6. I just don't like smelling armpits.
Frequency	35	F1. You never know when it will arrive. For that reason, most of the people use cars. That is not good because this causes traffic jam. F1. There are a lot of transportations but they are still not enough to support the population. F1. I think it's punctuality, frequency. F1. Frequency. F1. I live in a place that we don't have access to buses. So I have to walk 1 km to go to the metro station. In that 1 km, I don't have any bus option. F1. I think frequency is very important because in my case, I had to take bus and then train. If the bus doesn't come, I had to wait an hour for the train. F1. I think it (multi-modal transport) may be if it works properly, we don't mind to use it more often. F1. They don't have carriages enough to support the amount of people. F1. I think the car is useful if you go out at night or to the areas that don't have a lot of transport or long-distance trips. F1. I agree. F2. The worst part is not the time but the quality of transportation. There are some lines of the metro that it's super crowded and you have to wait for other cars and it's too bad. F2. I think public transport is very slow in here. I can wait for a tram for an hour. And subway is in every 15 minutes. Frequency is not enough for the amount of people. F2. Yes. During night F2. (Nods) F2. Sometimes you never know when the bus will come. If I'm going somewhere in near distance, I always check Uber how much does it cost. If it is low cost, I prefer Uber. F2. What works for me is the car. Because I work somewhere that public transportation is really bad, the car makes it really faster, more comfortable although it's a bit more expensive. F2. In the rush hours the metro is so crowded F2. Looking at screen for bus time schedules, all the time is problematic. F2. I used to be more comfortable going out by car at nights. Going out without a car is too much work for me. It's easier for me to leave whenever I want. F3. Schedules are better here in Lisbon. There are more options also. F3. In small cities you can easily walk or use tram. So I think it depends on the city. In Turkey, train is not as common as here, but buses are more frequent and more effective. F3. Maybe sometimes it's a little bit related with mobility But it's not because I don't have a car. It's just because I feel lazy to spend time to go somewhere just to have fun. F3. On the weekends, it's a lot harder for me to go to places because of the low amount of transportation. F3. When I was living in the city center, sometimes in the afternoon, I was going to have a coffee and then come back. But right now, I'm living a little far away I don't go out that often. F3. At night, there are no buses that go where I live. The only option is taxi or train which has limited hours. F4. In my country, people use their cars because public transport is not reliable and decent. F4. It should be 24 hours or at least more than one in the morning because it limits you. I live far from city center, because it's very expensive to live there. Whenever we go out with friends in the center, I always have to leave before 1am.

		F4. There's public transport there's not enough vehicles, especially buses. F4. Yeah. Yeah. F4. If friends say let's go out on a Saturday evening, you need to take the train and the ferry. Sometimes you have to wait in the cold outside and yes it happens. F5. To go out at night in Lisbon is an issue. F5. Yes. F5. I live in Cascais and the last train is at midnight so sometimes when we go out, I have to sleep at my friend's house which is not very satisfying. F6. Even though we have transportation, they have a schedule. At nights, you have limited options. F6. Most of the time transportation stop at 1 or 2am. So, you need to wait until 6 o'clock in the morning.
Facilities	34	F1. They have electric buses and what is really good for the environment. But the problem is that they are very slow. F1. We as designers need to carry lots of stuff all the time. That's an issue of course. F1. It's not suitable for all clothes and also if we have to carry some stuff. F1. Yes, I saw many times in the buses, people are falling because of the way of driver drives. F1. (Confirm laugh) F1. If you know who's coming the next day with you, and I'm going to accept or decline the person. So I don't think it's bad. F1. I have to catch bus and the metro. And usually unless I have pockets in my jacket, I always carry the pass on my hand. F1. It is really cold on streets so you put a lot of jackets and then you enter to bus and it's too hot. F1. There shouldn't be a shocker temperature. It's really important, too. F2. I don't want to wait 40 minutes, I'm not gonna be here (bus stop) forever. F2. They have to arrange the parking situation because it is really annoying (scooter-sharing) F2. Yes. F2. Yes. F2. It has to be some kind of reward for sharing. I don't really want to share my car with others. F2. I just miss having a car when I go to the supermarket. F2. Looking at screen for bus time schedules all the time is a problem. F3. In Lisbon you have metro, buses, train and it's pretty good. It's not bad if there's no strike. F3. I hate traffic but I still I prefer to be on traffic than using the crowded metro or train. Because I'm sitting on my car with comfort listening to music. F3. The shared ones in the city they have special parking lots so you can only park there until some specific time. F3. I think it would be better to have everything free, everything open and have more people doing the job instead of the gates. Every time I go into metro, I need to wait for the queue to charge my card. F4. In my country, people use their cars because public transport is not reliable and decent. F4. I think one thing that drove me away from this was not having enough places to put it. I could use this for going from the metro to school, but there is no bike station close to here. F4. It doesn't make sense to me that there are zones and the price is changing. I can't afford to live in the center and I have to pay more than the people who can afford to live in center. With one ticket and you should go everywhere. F5. Metro in Lisbon is much cleaner and bigger which is better. F5. If you don't have a card, you can pay to the drive to the driver but there must be a system that you should be able to pay with your credit card directly inside. F5. Buying a separate ticket for the transport can be replaced. F5. I already pay for the public transport, why am I going to pay for bikes or scooters additionally? F5. I wish I had money to use. You don't need to drive, you can look at your phone or read. F5. Heat. F5. There was one time I almost faint. F5. If I could use the same card for public transport with bikes, I would use it. F6. Sometimes it is crazy inside of the buses because of the air conditioning. F6. By walking you don't have to pay anything. It's healthy, you can just put your headphones and listen to music which makes you feel good. F6. Sometimes I just want a green line, without using transportation cards, validation on gates or buses. It would be so good.
Confusing	26	F1. The map of the metro is like a maze F1. I agree that there are lots of scooter brands and I'm lazy to download the apps F1. I agree. F1. downloading is easy but not paying part. The worst is that I don't understand when I have to pay. Because there are discounts which you only have to pay the first entry but after 20 minutes ride, you pay something else, I mean it is confusing. F1. It's hard to find the device that belongs to the app you have. F1. this already happened to many people that I know because sometimes we have to disconnect but they forget to turn it off. F1. They don't want to have the trouble of downloading and understand and know. F2. I totally agree. F2. Agree. F2. I agree. F2. There are too many scooter brands. F2. I downloaded one of the apps of scooters. Then I couldn't find the brand.

		F3. That's actually correct. F3. There are 10 different brands of this stuff. F3. Yes, that's also I kind of agree. F3. You know what I went to Algarve and they had shared biking there. All you need was to put a quarter in. For me that was the best. And there were designated places where you put bikes in then you would get your money back. All that apps are complicated. F3. And then you will be kind of stuck with the bike. Where am I going to put it and you'll be charging. F4. The app is wrong. F4. I feel like I said that (the quote given). F4. Yes. This is for everything if it's money I double check. F4. Sometimes it's not clear how they charge it. F5. How well developed is the network too because sometimes when you go to one metro station you have to walk so much to find the other stations. The stations are very distant. F5. Yes, it's complicated. There are lots of information. F6. When there are more lines it might be confusing. F6. I didn't know how to walk in the subway first time I came here. Because I couldn't understand it. After I did that one time or two, I've known what to do. F6. Yes, that's one of the reasons.
Lack of option	25	F1. I live in a place that we don't have access to buses. So I have to walk 1 km to go to the metro station. In that 1 km, I don't have any bus option. F1. I agree. F1. I agree. The options that you have for transportation doesn't work so well than you might need it. F1. I agree. F1. I agree. I use these excuses to not go like oh, I can go. We don't have Metro, I can't go back home by Uber because I don't have money. F2. If you are living outside, then you need a personal car. Distance is important. F2. Big cities have Metro and other possibilities. Yeah, real around. But I used to live in a small city when I was a kid, in there I've never walk a block in my whole life. Everyone was using cars. F3. In small cities you can easily walk or use tram. So I think it depends on the city. In Turkey, train is not as common as here, but buses are more frequent and more effective. F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes. F3. If I can find bikes everywhere and leave anywhere I want, I might prefer it more. F3. The shared ones in the city they have special parking lots so you can only park there until some specific time. F3. And then you will be kind of stuck with the bike. Where am I going to put it and you'll be charging. F3. When I was living in the city center, sometimes in the afternoon, I was going to have a coffee and then come back. But right now, I'm living a little far away I don't go out that often. F4. It should be 24 hours or at least more than one in the morning because it limits you. I live far from city center, because it's very expensive to live there. Whenever we go out with friends we go to the center of the city and I always have to leave before 1am. F4. I only use a taxi when it's after 1am. F4. I think one thing that drove me away from this was not having enough places to put it. I could use this for going from the metro to school, but there is no bike station close to here. F4. Depends where you live. F4. If friends say let's go out on a Saturday evening, you need to take the train and the ferry. Sometimes you have to wait in the cold outside and yes it happens. F5. I had to use car all the time because we didn't have metro. F5. I live in Cascais and the last train is at midnight so sometimes when we go out, I have to sleep at my friend's house which is not very satisfying. F5. Sometimes I cannot even find night buses to certain places. So I need to call Uber. F6. For example, in Porto there are different lines that go to same stops so you don't have to change the lines and gives you an option. F6. The problem with bike-sharing is you can't leave the bike anywhere. You have to put in its station. This means that oh I need to go to this place, but I need to walk 20 meters to put it in the right spot. F6. Even though we have transportation, they have a schedule. At nights, you have limited options. F6. Most of the time transportation stop at 1 or 2am. So, you need to wait until 6 o'clock in the morning.
Comfort	24	F1. Comfort. F1. there is a part of bench that is textile. F1. I think a coverage of seats, the textile is really important instead of simple plastic. F1. Not that comfortable. F1. Rush hours are very very crowded. I have to stand and I am small so I travel with armpits around me. F1. I totally agree. F1. If the distance is short, bikes are good. It's not suitable for all clothes and also if we have to carry some stuff. F1. Yes.

		F1. There shouldn't be a shocker temperature. It's really important, too. F2. What works for me is the car. Because I work somewhere that public transportation is really bad, the car makes it really faster, more comfortable although it's a bit more expensive. F2. I just miss having a car when I go to the supermarket. F3. I use my car because I do like the comfort. F3. Comfort. F3. Yes. F3. Yes. F3. I still prefer to have a personal bike, walk and my car. I mean it can sound a bit selfish but I like to have my own schedule my own approach. F3. I hate traffic but I still I prefer to be on traffic then use the crowded metro or train. Because I'm sitting on my car with comfort listening to music. F4. It's because I have a family. Car is great when you have kids, because there you don't have to depend. F5. When we have more money, we might want to be more comfortable and may want to use car. F5. It's exhausting. F5. To go to school is fine but going back is harder because you became tired. F5. I prefer if I'm with friends I can say can you also pick me? F6. Bus is not always great because it is crowded and uncomfortable, there is no place to sit, you just stand up and it shakes a lot. F6. It's not because I'm not thinking about the environment is more like, I don't like to do that. I do not feel comfortable doing that (bus).
Digital app	24	F1. There are applications that show the time and it's always correct. F1. Not really. F1. Here is not F1. There's an app for the buses but lots of the time it is not correct. F1. I use it every day, it's like, the apps are accurate a lot of the time and then sometimes it just doesn't work. Or it says five minutes. You wait five minutes, and then bus appears, you realize that thirty minutes passed. F1. I agree that there are lots of scooter brands and I'm lazy to download the apps F1. I agree. F1. downloading is easy but not paying part. The worst is that I don't understand when I have to pay because then they are like discounts and they say oh you have to pay the first entry but the 20 minutes ride, I mean it is confusing. F1. this already happened to many people that I know because sometimes we have to disconnect but they forget to turn it off. F1. They don't want to have the trouble of downloading and understand and know. F2. Even if it is not frequent, to know when the bus or train is coming is always good. F2. I totally agree. F2. Agree. F2. I agree. F3. Yeah, that's, that's exactly I feel about it. Even if I would want to try one, I never did because you install an app. And then you get somewhere and there's a different brand. F3. Yes, that's also I kind of agree. F3. You know what I went to Algarve and they had shared biking there. All you need was to put a quarter in. For me that was the best. And there were designated places where you put bikes in then you would get your money back. All that apps are complicated. F4. I used an app before that you introduce your destination and it shows you how to go. But when you know the area, you understand that those are not the best options. F4. The app is wrong. F4. I feel like I said that (the quote given). F4. Yes. This is for everything if it's money I double check. F5. But in Lisbon the Carris app says the bus will come in 10 minutes, but actually comes in 30 minutes. F5. Yes, it's complicated. There are lots of information. F5. You need to download, put your card number, then discover how the thing works F5. Yes. It takes time.
Lack of route	23	F1. I live in a place that we don't have access to buses. So I have to walk 1 km to go to the metro station. In that 1km, I don't have any bus option. F1. I hate changing transportation. F1. I agree. F1. I agree. I use these excuses to not go like oh, I can go. We don't have Metro, I can't go back home by Uber because I don't have money. F2. If you are living outside, then you need a personal car. Distance is important. F2. I hate taking the metro and changing the line. Taking bus and then metro is worse. F2. The problem is the time you lose between the two transport. I feel like I wait more then, direct transport but maybe it's psychologically. F3. In small cities you can easily walk or use tram. So, I think it depends on the city. In Turkey, train is not as common as here, but buses are more frequent and more effective.

		F3. Multi modal transportation is the least preferred one. You lose a lot of time during the changes. F3. That's horrible. F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes. F3. I still prefer to have a personal bike, walk and my car. I mean it can sound a bit selfish but I like to have my own schedule my own approach. F3. At night, there are no buses that go where I live. The only option is taxi or train at those limited hours. F4. It should be 24 hours or at least more than one in the morning because it limits you. I live far from city center, because it's very expensive to live there. Whenever we go out with friends we go to the center of the city and I always have to leave before 1am. F4. I have to combine transports everyday and it's really annoying. If we miss one bus, we have to wait for an hour for the next one. F4. Some cities are designed for cars, so it's very hard to walk over because of the cars everywhere. F4. There are no real streets here for the bike. F4. Yeah. Yeah. F5. And Lisbon has lots of hills and no special place so bikes are not suitable. F5. I don't want to live in the city so in the future I would need a personal car. F6. For example, in Porto there are different lines that go to same stops so you don't have to change the lines and gives you an option. F6. Sometimes you cannot find a bus that directly goes to a certain place, or close. Then you have to use more than one. F6. If there were bike roads, I might feel safer.
Personal space	20	F1. Being alone in your car that drives in itself to the place. F1. If I had the money to buy a car and I bought a car, I wouldn't like to share with other people because they might damage. It's the hygiene issue and security. F1. They smell. F2. Sometimes, you just need some silence and want listen to my music. F2. When you share the car, you have this uncomfortable feeling like you have to talk. F3. It's also music and your own personal space. F3. But still you like different kind of music, I like the other kind, so… F3. Yes, exactly. F3. It's nice to share but I don't like it. I like my personal space. F3. Not even a friend or a colleague. Sometimes I don't want to speak to anyone. F3. I tried some time but it's always stressful. Because you might be a person that don't mind to get late. And lateness is really bothering me. I like to be punctual. F3. I'm the type of person that I feel like I want to stay, I'll stay or leave, I'll leave. You need to depend on a person when you share. F4. Sometimes I just feel like, I just want to go school, I don't want to talk. F5. I want my space. F5. It is a bit security issue. I don't want stranger in my car. F6. At the end of the day, sometimes a little time being alone is better. (ride-sharing) F6. In the subway everybody is talking so loudly. F6. There's no personal space. F6. I don't even share my car with my mum. It becomes your personal space and sometimes you store things inside. F6. Also, when somebody is driving your car, they need to change some stuff inside, rearrange them which is annoying.

Personal excuses	19	F1. Maybe sometimes you are just lazy to walk to the station or the major station F2. I think use of car is also cultural F2. I hate traffic but also like to drive long distance. F2. It's a line between like doing my part for the environment and limiting my lifestyle. It's very blurry. F2. To have a car is not really a status. Depends. F3. My mom never used public transportation. So, since I have my driver's license, I don't use public transportation. I just take my car. F3. I agree, I think parents also have a lot of influence. For example, mine always went to work using public transportation. So Exactly. F3. Personal car is my choice, no matter what because I do enjoy to drive F3. The anxiety when you need to get out of a public transport, but you cannot because of people. It is too crowded so you have to crash people or push people. F3. I'm the type of person that I feel like I want to stay, I'll stay or leave, I'll leave. You need to depend on a person when you share. F4. I might not even want to share with friends. F4. In Portugal, the stones of pavement are really hard to walk. F5. Who likes to walk? F5. Imagine if you have kids? Family? F5. My sister hates the metro because it makes her anxious because it's underground. She needs to use bus. F5. I'm more about the thing that in the morning or when I get off job, I'm too tired and I don't want to talk to anybody. I just want to go home. I could share but not talking. F5. we are having trouble changing our lifestyles, F6. I don't know I just cannot balance on them. F6. I just don't like smelling armpits.
Traffic/parking	17	F1. You never know when it will arrive. For that reason, most of the people use cars. That is not good because this causes traffic jam. F1. Of course, I would want the personal car, but I don't have. Not only because I don't have the money for that but for parking issue. F1. Parking, yes. F1. Parking is starting to be very expensive in Lisbon and the prices are getting higher. F1. I am not extremely satisfied with personal car in the city because of the parking spot issue. F2. Traffic is really bad and every distance is more than one hour. F2. They have to arrange the parking situation because it is really annoying (scooter-sharing) F2. Yes. F2. Yes. F2. Scooters are in the middle of the road. F2. I hate traffic but also like to drive long distance. F2. Parking my car, it's terrible. F3. I hate traffic but I still I prefer to be on traffic then use the crowded metro or train. Because I'm sitting on my car with comfort listening to music. F3. The only thing that I don't like about a personal car is the fact that everybody has it and then there's rush hour and then you're waiting for a long time. And no, I hate waiting. F3. You also have to be stressed about finding a place to put your car and again, it's the cost of parking the car, then it's the insurance. F4. My family have car but it's always a mess because of the parking in everywhere. Either you pay for everything or the one you don't need to pay are far. F5. I's expensive also. I have to look for a place to park, parking is expensive.
Maintenance/regulations	11	F1. They have wifi, they are new and not falling apart (bus). F1. And they cost like 1 or 2 euros to produce and then they earn a lot with them. They don't mind that some sent to the river or broken F1. If I had the money to buy a car and I bought a car, I wouldn't like to share with other people because they might damage. It's the hygiene issue and security. F3. To be honest, anything that is shared with bikes or scooters, I do not like. There's no monitoring there is no regulations, there's no maintenance. You don't know if they are working properly. F3. I think they're not regulated properly; people just leave them anywhere. F3. I think the problem is that sometimes you take the bike and start the trip, suddenly some noise starts to come. F3. No maintenance for bikes. F3. You also have to be stressed about finding a place to put your car and again, it's the cost of parking the car, then it's the insurance. F5. There is no maintenance that you need to do to your car. So car-sharing is really good. F6. Some people just throw scooters into the river and cause pollution. I saw that. F6. Once, I saw them in the tree. Why?

Weather	11	F1. It is really cold on streets so you put a lot of jackets and then you enter to bus and it's too hot. F1. It is really boring because you have to take off and put on and take off again if you're changing transport. F2. One day it's raining a lot and the other day it's sunny but there's one percentage of chance of rain, then ok no bike. F3. Scooter is very expensive and what about cold weather? F3. Yes. F3. Yes. F3. Exactly. F3. Walking would be fine because you can use umbrella. F4. It depends on the distance and weather also. Imagine it's raining and I have to cross the river. I'm not going to go to school. F6. The weather needs to be good for biking. F6. I think it depends on the weather if it's not cold or rainy, I might walk from Rossio to here.
Lack of information	8	F1. The problem is the lateness and not knowing when. F1. The problem nowadays is that I know the bus will come in 20 minutes but I don't know when exactly. F1. (nods) F2. Even if it is not frequent, to know when the bus or train is coming is always good. F3. To be honest, anything that is shared with bikes or scooters, I do not like. There's no monitoring there is no regulations, there's no maintenance. You don't know if they are working properly. F3. As long as I know how long it's going to take between all three (multimodal), I always get there on time or even before time. So for me, I don't mind multiple transportation. F5. It's difficult to know when the bus is coming, it can be more efficient. F6. Sometimes there's lack of information. For instance, they say the train will be late but you cannot see it from anywhere before getting inside of the gates.
Hygiene	6	F1. the hygiene F1. Seats can be very dirty. F1. Yes. F1. But that's actually better because it (fabric) accumulates dust. F1. If I had the money to buy a car and I bought a car, I wouldn't like to share with other people because they might damage. It's the hygiene issue and security. F5. Metro in Lisbon is much cleaner and bigger which is better.
Sustainab[illegible]	3	F1. Scooters are not eco-friendly. I read a publication about like, two or three days ago that actually scooters cause more pollution than cars. Fluence that to environment in college, because it has a lithium batteries. F1. I think we want to take it as a consideration but we don't take it. Because we all use public transport that are not eco-friendly. F1. If we have 2 buses that pass from our bus station, one that is eco-friendly and one is not, I would prefer eco-friendly one.

K. Focus Group Transcript Based on Demand Topics (Best Mobility System Must Have)

Topics	F	Quotes
Clean/ hygienic	4	F1. the hygiene. Seats can be very dirty. F1. Yes. F1. It's the hygiene issue F5. Metro in Lisbon is much cleaner and bigger which is better.
Clear information	20	F1. The map of the metro is like a maze F1. you have a map that you know when the bus is going to stop F1. downloading is easy but not paying part. The worst is that I don't understand when I have to pay because then they are like discounts and they say oh you have to pay the first entry but the 20 minutes ride, I mean it is confusing. F1. No, this already happened to many people that I know because sometimes we have to disconnect but they forget to turn it off. F2. I totally agree. F2. Agree. F2. I agree. F3. That's actually correct. Yeah, that's, that's exactly I feel about it. Even if I would want to try one I never did because you install an app. And then you get somewhere and there's a different brand. F3. Yes, that's also I kind of agree. F3. You know what I went to Algarve and they had shared biking there. All you need was to put a quarter in. For me that was the best. And there were designated places where you put bikes in then you would get your money back. All that apps are complicated. F4. The app is wrong. F4. There shouldn't be just one brand that own everything and make a monopoly because that's bad. But also I agree that having too many brands causes confusion. I don't have the time to actually research and stuff. F4. I feel like I said that. F4. Sometimes it's not clear how they charge it. F5. Yes, it's complicated. There are lots of imformation. F5. You need to download, put your card number, then discover how the thing works F6. When there are more lines it might be confusing. F6. I didn't know how to walk in the subway first time I came here. Because I couldn't understand it after I've done that just one time or two, I just know what to do. F6. Sometimes there's lack of information. For instance they say the train will be late but you cannot see it from anywhere before getting inside of the gates. F6. Yes, that's one of the reasons.
Comfortable	26	F1. Comfort. F1. there is a part of bench that is textile. F1. I think a coverage of seats, the textile is really important instead of simple plastic. F1. I think public transport is the best because it is cheap and comfortable. F1. Not that comfortable. F2. I don't mind paying little bit more for Uber, because the guy drives. F2. more comfortable F2. limiting my lifestyle. F2. I used to be more comfortable going out by car at nights. F3. I use my car because I do like the comfort. F3. Comfort. F3. Yes. F3. Yes. F3. I like my comfort F3. Uber is convenient. F3. You just grab your phone and the transport is just there. F3. I still prefer to have a personal bike, walk and my car. I mean it can sound a bit selfish but I like to have my own schedule my own approach. F3. I hate traffic but I still I prefer to be on traffic then use the crowded metro or train. Because I'm sitting on my car with comfort listening to music. F3. It's because I have a family. Car is great when you have kids, because there you don't have to depend. F5. When we have more money, we might want to be more comfortable and may want to use car.

		F5. Sometimes you are just tired to drive so autonomous vehicles can be a good opportunity. F5. I wish I had money to use. You don’t need to drive, you can look at your phone or read. F5. To go to school is fine but going back is harder because you became tired. F6. In trains, some lines are more crowded then others. Some trains have two floors so it’s better and more comfortable. You can sit. F6. Bus is not always great because it is crowded and uncomfortable F6. It's not because I'm not thinking about the environment is more like, I don't like to do that. I do not feel comfortable doing that.
Convenient price	58	F1. It'll be great but it also depends on the price. F1. Yes F1. yes. F1. This one is way more expensive one pay in one trip here. F1. I think public transport is the best because it is cheap and comfortable. F1. downloading is easy but not paying part. The worst is that I don't understand when I have to pay because then they are like discounts and they say oh you have to pay the first entry but the 20 minutes ride, I mean it is confusing. F1. No, this already happened to many people that I know because sometimes we have to disconnect but they forget to turn it off. F1. If I don’t pay for parking I would use car all the time. F1. The car is more expensive than paying for a month of public transport. F1. I don't know if you will pay your own gas, but I pay my and I am very, like, not strategic F1. Yes. F1. Yeah F1. I can’t go back home by Uber because I don’t have money. F2. Sometimes you never know when the bus will come. So if I’m going somewhere in near distance, I always check Uber how much does it cost. If it is low cost, I prefer Uber. F2. Mobility price must be convenient. F2. although it’s a bit more expensive. F2. If autonomous cars would be cheap, then I would use it every day. F2. Scooters are really expensive. F3. If I could and I have the money, I would choose autonomous vehicles. It’s a good combination of what I like in public transportation. F3. Convenient. F3. I’m not satisfied with cars. Because it costs. Gasoline, car maintenance. F3. I don't have a personal car because I don't want to stress and I don't want the expenses. F3. Rental car is really cost a lot. F3. Yes, they are expensive. F3. If autonomous car existed, it would be very expensive. F3. Scooter is very expensive F3. I believe this guy didn't try it because it's expensive. F3. And then you will be kind of stuck with the bike. Where am I going to put it and you'll be charging. F3. it's the cost of parking the car F3. I think it would be better to have everything free, F4. I pay 40 euros for month, it’s quite expensive actually. F4. I would say Madrid has a really good public transport and it's also really cheap. I would you say it's a little more expensive. F4. Price level is expensive in Madeira and it’s not worth it. F4. I think public transportation should be almost free for free. Transportation is a right to everyone. F4. I wouldn't like even if it's cheaper or eco-friendly, sharing is tricky. F4. If I have money, I prefer Uber. F4. Price is important. F4. My family have car but it's always a mess because of the parking in everywhere. Either you pay for everything or the one you don't need to pay are far. F4. If scooters were free, I would choose scooter. F4. I feel like if you want to have a personal ride you can just for Uber. To have your own is spending way too much resources F4. I don’t feel safe in Uber. Sometimes because of the driver and sometimes because of the payment method. Sometimes they take me from the long distance. F4. Bikes should be free. F4. It doesn't make sense to me that there are zones and the price is changing. I can’t afford to live in the center and I have to pay more than the people who can afford to live in center. With one ticket and you should go everywhere. F4. I feel like I said that. F4. Yes. This is for everything if it's money I double check. F5. To travel here became much cheaper than before. F5. Cheap. F5. I already pay for the public transport, why am I going to pay for bikes or scooters additionally?

		F5. I’s expensive also. I have to look for a place to park, parking is expensive. F5. When we have more money, we might want to be more comfortable and may want to use car. F5. Money is important. F5. If I could use the same card for public transport with bikes, I would use it. F5. If it was included, I would use it definitely. F6. Autonomous cars are cool but it's expensive. F6. I used bike-sharing sometimes with my family. It’s not that expensive. F6. By walking you don’t have to pay anything. F6. If it becomes cheaper, I would prefer autonomous. F6. Also, expensive.
Convenient routes	29	F1. I think the car is useful for if you go out at night for example, to the areas that don't have a lot of transport or long distance trips. F2. There are some lines of the metro that it's super crowded and you have to wait for other cars and it’s too bad F2. If you are living outside, then you need a personal car. Distance is important. F2. If I live and work in the city center, I would sell my car probably. F2. It’s easier for me to leave whenever I want. F3. There are more options also. F3. If one fails you can use a workaround. If you don’t have train, you can use the bus. F3. We only like even in Canada, we only use the car when it was like long distances. F3. more effective. F3. Convenient. F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes. F3. At night, there are no buses that go where I live. The only option is taxi or the trains at those limited hours. F4. In my country, people use their cars because public transport is not reliable and decent. F4. I haven't been in there for two years, but when I left the buses and the lines were very good. I almost never took a taxi. I would always get the buses or the metro. F4. I only use a taxi when it's after 1am. F4. If you live in a farm of course you need a car but in city no. F4. There are no real streets here for the bike. F4. We have a lot of hills and you have to go up a lot so it's not really suitable and dangerous. F5. How well developed is the network too because sometimes when you go to one metro station you have to walk so much to find the other stations. The stations are very distant. F5. And Lisbon has lots of hills and no special place so bikes are not suitable. F5. I don't want to live in the city so in the future I would need a personal car. F5. To go out at night in Lisbon is an issue. F5. Yes. F6. For example, in Porto there are different lines that go to same stops so you don’t have to change the lines and gives you an option. F6. Sometimes you cannot find a bus that directly goes to a certain place, or close. Then you have to use more than one. F6. If public transportation gets better maybe people would be more satisfied. F6. If there were bike roads, I might feel more safe. F6. Drivers don’t like cars on the road, they hate it. F6. Even though we have transportation, they have a schedule. At nights, you have limited options.
Easily reachable	26	F1. The map of the metro is like a maze F1. we don't have access to buses. So I have to walk 1 km to go to the metro station. In that 1kilometer, I don't have any bus option. If I walk one kilometer and a half, I could get to a bus station and we have one option of line to use. So, it's really bad. F1. It's hard to find the device that belongs to the app you have. F1. I think the car is useful for if you go out at night for example, to the areas that don't have a lot of transport or long distance trips. F2. I downloaded one of the apps of scooters. Then I couldn’t find the brand. F2. One hour or two hours for mobility, I need that time. F3. Multi modal transportation is the least preferred one. You lose a lot of time during the changes. F3. You just grab your phone and the transport is just there. F3. If I can find bikes everywhere and leave anywhere I want, I might prefer it more. F3. The shared ones in the city they have special parking lots so you can only park there until some specific time. F3. And then you will be kind of stuck with the bike. Where am I going to put it and you'll be charging. F3. It's just because I feel lazy to spend time to go somewhere just to have fun. F3. When I was living in the city center, sometimes in the afternoon, I was going to have a coffee and then come back. But right now, I'm living a little far away I don't go out that often. F4. If I have money, I prefer Uber. F4. I think one thing that drove me away from this was not having enough places to put it. I could use this for going from the metro to school, but there is no bike station close to here.

		F4. Depends where you live. F4. If friends say let's go out on a Saturday evening, you need to take the train and the ferry. Sometimes you have to waitin the cold outside and yes it happens. F5. How well developed is the network too because sometimes when you go to one metro station you have to walk so much to find the other stations. The stations are very distant. F5. You can call uber for emergency. I don't agree. F5. Sometimes I cannot even find night buses to certain places. So I need to call Uber. F6. The problem with bike-sharing is you can't leave the bike anywhere. You have to put in its station. This means that oh I need to go to this place, but I need to walk 20 meters to put it in the right spot. F6. When you have a backpack it's hard to arrange things on gates. F6. Sometimes I just want a green line, without using transportation cards, validation on gates or buses. It would be so good. F6. Most of the time transportation stop at 1 or 2am. So, you need to wait until 6 o'clock in the morning. F6. Yes, I trust Uber. F6. I would just take Uber.
Enough space	37	F1. not enough to support the population F1. Sometimes it gets really crowded and there's no space to sit. Space is important. F1. Yes. F1. (Nod) F1. Where to sit F1. Agreed all. F1. Rush hours are very very crowded. I have to stand and I am small so I travel with armpits around me. F1. I totally agree. F2. There are some lines of the metro that it's super crowded and you have to wait for other cars and it's too bad F2. Between 6pm and 7pm trains are also very crowded. F2. I agree. F2. It's so full that you cannot even get inside. (bus) F2. Yes. F2. (Nods) F2. In the rush hours the metro is so crowded so I prefer to walk. F3. People should be able to sit. F3. It's also music and your own personal space F3. I agree with. F3. Yes me too. F3. I agree F3. (Nods) F3. The anxiety when you need to get out of a public transport, but you cannot because of people. It is too crowded so you have to crash people or push people. F4. Metro gets very full between 6pm and 7pm F4. I hate it. F4. When the metro is all packed, some can easily steal your phone and take advantage of the crowd. F4. It's a huge problem. F5. Space is important. F5. You can not see, you cannot breathe. F5. Yes, everything. F6. Sometimes it is crazy inside of the buses because of the air conditioning. F6. I need to breath. F6. In the summer it's terrible. F6. Bus is not always great because it is crowded and uncomfortable, there is no place to sit, you just stand up and it shakes a lot. F6. Yes. F6. I agree. F6. I just don't like smelling armpits. F6. There's no personal space.
Fast	34	F1. But the problem is that they are very slow. F2. Traffic is really bad and every distance is more than one hour. F2. I think public transport is very slow in here. F2. I work in Carnaxide and to get there is terrible. With car it's 15 minutes but by bus it's 1 and a half hour. If my car breaks down, I'll cry. F2. the car makes it really faster F2. I hate taking the metro and changing the line. Taking bus and then metro is worse. F2. The problem is the time you lose between the two transport. I feel like I wait more then direct transport but maybe it's psychologically. F3. Also, the main reason is to go to work it takes 45 minutes to 1 hour but with car it's 10 minutes.

		F3. Private cars take longer especially during the rush hours. Train is much more faster. F3. We only like even in Canada, we only use the car when it was like long distances. F3. it would also make my ride shorter. F3. I would like to go from point A to B in fastest time F3. Multi modal transportation is the least preferred one. You lose a lot of time during the changes. F3. That's horrible. F3. You just grab your phone and the transport is just there. F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes. F3. If I need to be there in a very short time instead of walking, I would prefer biking. F3. The only thing that I don't like about a personal car is the fact that everybody has it and then there's rush hour and then you're waiting for a long time. And no, I hate waiting. F3. It takes 30 minutes if you are passing the bridge in rush hours, not 10 minutes. But it's still faster than public transportation. F3. Every time I go into metro, I need to wait for the queue to charge my card. F3. It's just because I feel lazy to spend time to go somewhere just to have fun. F4. What is good with the metro that you don't get suck in the traffic. You always know when you're going to get a place in certain time. F4. I used to do this (multi modal) back in England, and the downside is that you wait a lot F4. I have to combine transports everyday and it's really annoying. If we miss one bus, we have to wait for an hour for the next one. F4. Depends where you live. F5. There are lots of buses and they travel quicker. They're more efficient with this way. F5. Sometimes I carry my skateboard around but just to save up 7 minutes of walking. F5. Big issue about walking is the time that it takes. F5. Yes. It takes time. F5. You can call uber for emergency. I don't agree. F5. Sometimes uber takes a lot time to come. So you need a car. F6. If I really need like to go somewhere quicker, I think I would call for Uber. F6. This is so me. F6. Sometimes I just want a green line, without using transportation cards, validation on gates or buses. It would be so good.
Frequent	57	F1. not enough to support the population F1. You wait five minutes, and then bus appears, you realize that thirty minutes passed. F1. The problem is the lateness and not knowing when F1. frequency F1. Frequency. F1. I think frequency is very important because in my case, I had to take bus and then train. If the bus doesn't come, I had to wait an hour for the train. F1. I think it (multi-modal transport) may be if it works properly, we don't mind to use it more often F1. It's a lot of waiting time. F1. If the transports are super effective and works properly, walking would be less preferred. Now I walk more because I prefer to walk rather than wait for a bus for 20 minutes. F1. Rush hours are very very crowded. F1. I totally agree. F1. They don't have carriages enough to support the amount of people. F1. I think the car is useful for if you go out at night for example, to the areas that don't have a lot of transport or long distance trips. F1. The options that you have for transportation doesn't work so well, then you might need it. F2. There are some lines of the metro that it's super crowded and you have to wait for other cars and it's too bad F2. I can wait for a tram for an hour. And subway is in every 15 minutes. Frequency is not enough for the amount of people. F2. Yes. During night F2. (Nods) F2. Between 6pm and 7pm trains are also very crowded. F2. I don't want to wait 40 minutes, I'm not gonna be here (bus stop) forever. F2. When we consider the timing is perfect, you can bike, go to metro and bus. F2. In the rush hours the metro is so crowded so I prefer to walk. F2. I hate taking the metro and changing the line. Taking bus and then metro is worse. F2. The problem is the time you lose between the two transport. I feel like I wait more then direct transport but maybe it's psychologically. F2. One hour or two hours for mobility, I need that time. F2. It's easier for me to leave whenever I want. F3. Schedules are better here in Lisbon. F3. Also, the main reason is to go to work it takes 45 minutes to 1 hour but with car it's 10 minutes.

		F3. buses are more frequent F3. In Moscow, metro comes in every 2 minutes. F3. Multi modal transportation is the least preferred one. You lose a lot of time during the changes. F3. That's horrible. F3. It takes 45 minutes because I need to take the train, then I need to go to a metro. And that's the multimodal. If I can come directly by train, I would avoid car because it would take me 30 minutes. F3. The anxiety when you need to get out of a public transport, but you cannot because of people. It is too crowded so you have to crash people or push people. F3. It's just because I feel lazy to spend time to go somewhere just to have fun. F3. On the weekends, it's a lot harder for me to go to places because of the low amount of transportation. F3. When I was living in the city center, sometimes in the afternoon, I was going to have a coffee and then come back. But right now, I'm living a little far away I don't go out that often. F3. At night, there are no buses that go where I live. The only option is taxi or the trains at those limited hours. F4. In my country, people use their cars because public transport is not reliable and decent. F4. When I use bus, it takes 2 hours sometimes. F4. It should be 24 hours or at least more than one in the morning because it limits you. F4. I only use a taxi when it's after 1am. F4. I have to combine transports everyday and it's really annoying. If we miss one bus, we have to wait for an hour for the next one. F4. there's not enough vehicles, especially buses. F4. Metro gets very full between 6pm and 7pm F4. Yeah. Yeah. F4. If friends say let's go out on a Saturday evening, you need to take the train and the ferry. Sometimes you have to waitin the cold outside and yes it happens. F5. To go out at night in Lisbon is an issue. F5. Yes. F5. I live in Cascais and the last train is at midnight so sometimes when we go out, I have to sleep at my friend's house which is not very satisfying. F5. Sometimes I cannot even find night buses to certain places. So I need to call Uber. F6. In the morning like really like seven o'clock, there's a lot of people in the train. It's packed but 10 o'clock more relaxed. F6. In trains, some lines are more crowded then others. Some trains have two floors so it's better and more comfortable. You can sit. F6. In the summer it's terrible. F6. If public transportation gets better maybe people would be more satisfied. F6. Even though we have transportation, they have a schedule. At nights, you have limited options. F6. Most of the time transportation stop at 1 or 2am. So, you need to wait until 6 o'clock in the morning.
Maintained and repaired	10	F1. They are always trying to innovate them. F1. new and not falling apart F1. They don't mind that some sent to the river or broken F1. It is really cold on streets so you put a lot of jackets and then you enter to bus and it's too hot. F3. To be honest, anything that is shared with bikes or scooters, I do not like. There's no monitoring there is no regulations, there's no maintenance. You don't know if they are working properly. F3. I think they're not regulated properly, you know, people just leave them anywhere. F3. I think the problem is that sometimes you take the bike and start the trip, suddenly some noise starts to come. F3. No maintenance for bikes. F3. It's the maintenance and costly. F5. There is no maintanence that you need to do to your car. So car-sharing is really good.
Offer efficient facilities	18	F1. They have wifi F1. It is really cold on streets so you put a lot of jackets and then you enter to bus and it's too hot. F1. There shouldn't be a shocker temperature. It's really important, too. F2. I just miss having a car when I go to the supermarket. F3. But I really like the fact that I can do stuff while I'm on the public transportation like reading a book, working on stuff, F3. It's also music and your own personal space F4. The greatest thing would be to have apps that everyone would be sharing a car. F4. It doesn't make sense to me that there are zones and the price is changing. I can't afford to live in the center and I have to pay more than the people who can afford to live in center. With one ticket and you should go everywhere. F4. When I have groceries with you in the bus it's the worst. If I cannot carry it on myself I just call Uber. F5. I was using an app that shows the time of bus so I knew when I need to leave home which is good. F5. Metro in Lisbon is much cleaner and bigger which is better. F5. If you don't have a card, you can pay to the drive to the driver but there must be a system that you should be able to pay with your credit card directly inside. F5. Buying a separate ticket for the transport can be replaced. F5. You don't have helmet and you can me in the middle of the cars so it's dangerous. No one is walking with the helmet.

		F5. Heat. F5. If I could use the same card for public transport with bikes, I would use it. F5. If it was included, I would use it definitely. F6. Sometimes it is crazy inside of the buses because of the air conditioning.
Punctual	30	F1. You never know when it will arrive F1. buses always come on time which is really nice F1. punctuality F1. The problem nowadays is that I know the bus will come in 20 minutes but I don't know when exactly. F1. (nods) F1. (nods) F1. I think it's punctuality F1. I think frequency is very important because in my case, I had to take bus and then train. If the bus doesn't come, I had to wait an hour for the train. F1. I think it (multi-modal transport) may be if it works properly, we don't mind to use it more often F1. If the transports are super effective and works properly, walking would be less preferred. Now I walk more because I prefer to walk rather than wait for a bus for 20 minutes. F2. The most important thing is to be on time. F2. I don't want to wait 40 minutes, I'm not gonna be here (bus stop) forever. F2. When we consider the timing is perfect, you can bike, go to metro and bus. F2. One hour or two hours for mobility, I need that time. F3. Timing. F3. I still prefer to have a personal bike, walk and my car. I mean it can sound a bit selfish but I like to have my own schedule my own approach. F3. I tried some time but it's always stressful. Because you might be a person that don't mind to get late. And lateness is really bothering me. I like to be punctual. F4. In my country, people use their cars because public transport is not reliable and decent. F4. When I use bus, it takes 2 hours sometimes. F4. We use ferry from Caparica to here, and it's always on time and in every 15 minutes. F4. What is good with the metro that you don't get suck in the traffic. You always know when you're going to get a place in certain time. F4. I used to do this (multi modal) back in England, and the downside is that you wait a lot F4. I have to combine transports everyday and it's really annoying. If we miss one bus, we have to wait for an hour for the next one. F5. But in Lisbon the Carris app says the bus will come I 10 minutes, but actually comes in 30 minutes. F5. I agree with that timing. F5. It's difficult to know when the bus is coming, it can be more efficient. F5. Timing is important. F5. Yes. F6. I was late today because they decided not to make that schedule and it happens a lot. F6. Timing.
Reliable information	22	F1. You never know when it will arrive F1. there are timetables on bus stops. So you can see when the bus is coming. F1. Not really. F1. Here is not F1. There's an app for the buses but lots of the time they're not correct. F1. the apps are accurate a lot of the time and then sometimes it just doesn't work F1. You wait five minutes, and then bus appears, you realize that thirty minutes passed. F1. Five minutes is like ten minutes F1. Even if you have to wait like five more minutes, it's better than nothing. F1. The bus stops have numbers that you can text to see the time of the bus. F1. The problem is the lateness and not knowing when F1. Timetables or in the app, it says 5 minutes. But that 5 minutes is like 10 minutes. F1. If you know who's coming the next day with you, and I'm going to accept or decline the person. F2. Even if it is not frequent, to know when the bus or train is coming is always good. F2. Sometimes you never know when the bus will come. So if I'm going somewhere in near distance, I always check Uber how much does it cost. If it is low cost, I prefer Uber. F3. As long as I know how long it's going to take between all three (multimodal), I always get there on time or even before time. F4. I don't feel safe in Uber. Sometimes because of the driver and sometimes because of the payment method. Sometimes they take me from the long distance. F4. I used an app before that you introduce your destination and it shows you how to go. But when you know the area, you understand that those are not the best options. F4. The app is wrong.

		F4. I feel like I said that. F5. I was using an app that shows the time of bus so I knew when I need to leave home which is good. F5. I agree with that timing.
Secure	49	F1. there are buses which are safer. F1. because of harassment. F1. I think security is also important. F1. Yes. F1. True. F1. I saw many times in the buses, people are falling because of the way of driver drives. F1. (Confirm laugh) F1. everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. F1. I trust more when people driving. F1. security. F1. Security problem. F1. If you know who's coming the next day with you, and I'm going to accept or decline the person. F1. That's okay but if I have to share with strangers, I wouldn't do that. F1. I would like to share with our people but in the reality I, I came from a country that is not safe even to say hi to people on the street. So this is a texture that for me it's really relevant I have to be prejudice. F1. I don't prefer to walk at nights. F2. If I know people I would share. F2. Using Uber as a woman alone is also dangerous in Brazil, for instance. F2. Yes. I mostly share my locations with my friend or family when I was in Taxi. F3. the only reason why I won't choose autonomous vehicles that I'm scared that something might go wrong. F3. To be honest, anything that is shared with bikes or scooters, I do not like. There's no monitoring there is no regulations, there's no maintenance. You don't know if they are working properly. F3. I think they're not regulated properly, you know, people just leave them anywhere. F3. To share the car with people you don't know.. F3. The whole thing that being your data tracked and everything, I don't want them F3. I don't like other people knowing where I am and when I am in somewhere exactly. I like my privacy. F4. It depends. I mean as a woman I wouldn't prefer it. F4. I feel like public transport especially for woman is a bit vulnerable in certain situations. F4. I don't feel safe in Uber. F4. When the metro is all packed, some can easily steal your phone and take advantage of the crowd. F4. Sometimes I have expensive things in my backpack, laptop or my camera for instance. I don't want to go with a bicycle that I'm so vulnerable to falling or something. F4. There are no real streets here for the bike. F4. We have a lot of hills and you have to go up a lot so it's not really suitable and dangerous. F4. There are mean people outside. F5. In Brazil you don't feel secure when you take a bus or metro. F5. I hate scooters I think it's not safe. F5. You don't have helmet and you can me in the middle of the cars so it's dangerous. No one is walking with the helmet. F5. It is a bit security issue. I don't want stranger in my car. F6. Drivers don't respect bikers. F6. The scooters are awful, they are everywhere and very dangerous. I fell one time. F6. I don't know I just cannot balance on them. F6. It's not secure and inconvenient. F6. As for instance, we are girls and there are so creepy guys. F6. Yes. F6. (Nods) F6. That's another problem with crowd that is sometimes cause harassment. F6. I go to university with my computer and lots of stuff, I can't ride a bike with them. F6. I don't feel safe while riding a bike. People, drivers can crush easily. F6. If there were bike roads, I might feel more safe. F6. Drivers don't like cars on the road, they hate it. F6. It's kind of hard to feel secure in someone else's car.
Sustainable	14	F1. Actually the scooters are more harmful to environment. F1. Scooters are not eco-friendly. I read a publication about like, two or three days ago that actually scooters cause more pollution than cars. Fluence that to environment in college, because it has a lithium batteries. F1. They have electric buses and what is really good for the environment. F1. If we have 2 buses that pass from our bus station, one that is eco-friendly and one is not, I would prefer eco-friendly one. F1. I support all the time bike. Because they are green and cars are not the answer. F2. If the system is not really good, it is hard to do your part for the environment. F2. It's a line between like doing my part for the environment and limiting my lifestyle. It's very blurry.

F3. Yeah, I'm a like my goal for the like my car but I also I do my recycling, I care about these things. I care about the lights off when I don't need them.
F4. I wouldn't like even if it's cheaper or eco-friendly, sharing is tricky.
F4. I feel like if you want to have a personal ride you can just for Uber. To have your own is spending way too much resources
F4. I don't have a personal car, my family. We do like a lot of things that we believe are just like what we can do
F5. If everyone thinks like that, then what's gonna happen?
F6. It's healthy
F6. It's not because I'm not thinking about the environment is more like, I don't like to do that. I do not feel comfortable doing that.

L. Expert Evaluation Interview Transcript and Analysis

E1 ***1991 – Interface design, product design – Industrial design (PhD) – Teaching assistant, Researcher***

CO	CS	Satisfaction Scale	Expert Statement
1	1a	5	Both men and women can use this product independently of any different size options. It is not clear how user is going to interact with this product. When I see earphones, I feel like I will hear the feedback from earphones. I am not sure what I am going to see on this product screen over my palm. What is the difference between the inside and outside screen? Half gloves for sport activities are also mostly unisex products. Product's location on hand is truly meaningful for avoiding gender and body proportion. Also, I think it is nice to control the interaction with other city objects on my hand. It might be a bracelet, also. Couple of years ago, we were not even familiar with smart watches, answering calls or texting via watch or tracking activities or anything. Now, this technology has expanded worldwide. Most of the people in societies learnt how to deal with this technology so I can say we are ready. It became habit to have feedback from watches or bracelets. Smart watch and smart bracelets might have been considered as they are gender and body free options.
2	1b	2	Everyone can see it if I attach this on my clothes. It is also visible on my hand but it is more noticeable on the clothes. Users would prefer to put this glove on less noticeable part, maybe inside of the clothes. Is it possible? Like, inside of the pocket. I don't want my phone screen to be seen by anyone. If I am with some people I don't know, I mostly lower the screen brightness. I haven't thought that I might fold it, yes true, I can fold and put it in my pocket. I can reshape it since it is a flexible fabric. I would prefer to put it somewhere that I can still see the screen. Maybe it is better to put it on sleeve, but I would not attach it on my pants for instance. I would definitely prefer to put it close to me that I don't lose the eye contact. Users might not prefer to fold it. You know, people are primarily more cautious to the technology they don't know. So, they might have a sense that they might damage it. I found it a bit too much. Fashion perception would make a difference how people use this product probably. I wouldn't prefer to locate it on my body for a long time. The screen may contain private messages that I don't want to share.
3	1c	5	I have doubts about the small ones (3-4) that user need to wear on thumb and point finger. For instance, it may cause discomfort when I need to call someone with this product. Do I need to wear this all day? I can take it of while sleeping but what about during the day? The small options might have possibility to slip and drop during the day. If I don't take this off during the day time to time, maybe there is no possibility to drop it. For example, I drop my belongings during the day all the time, even my rings when I play with them. If I take this off one time in a day, it might not bother me. Since we are talking about future, there was used to be a watch that covers the wrist immediately when you tap the wrist. Maybe you can use that kind of material that may avoid the slipping. I don't need to approach my mouth with my hand in order to interact with the product? My hand would be down when I wear this, so it might better for the product to vibrate to notify me. Or it can speak to me. I don't really prefer light or other visual feedback but vibration or audio return could be better. When I am in the crowd I might not hear or see the feedback. 3-4 options have really small screens so not good for detailed feedback or notifications. I think the most appropriate one is the 1st option. If users want to continue their habits, they would prefer 1st option which is more recognized. I think it is a good idea to have a product on wrist. Because clothes might cover it. But it is not easy to cover something on hand. Smaller size options offer very limited interaction surface, especially if it interacts with text. It is better to have wider screen.
4	2a	3	Users might feel free to use this wearable with any kinds of clothes. Of course, it is beneficial to combine the wearable with the clothes I prefer to wear. I don't need to wear this with a specific jacket. I can choose any kind of clothes. It is also good to use this product with all the jackets we prefer. It might influence users to adopt a habit of use this new product. But the glove is the same, so I am not sure if it fits for all fashion tastes. Because I cannot change it.

5	2b	4	Mobile phone's appearance is not changeable also. But I can customize the screen background. Or I can choose the icons I want and customize the product via interface. It might be same for this wearable. We used to customize backpacks with pins or badges. For instance, I put the ones with my favourite cartoon characters or other stuff. Maybe I can do the same with this one. Is there any area on the glove for this customization? Can I put the first letters of my name? I use my palm anything I want to hold during the day. This might limit the movement of my hand. Of course, the technology might evolve. But you must think what if to hold something hot, what if I need to wash my hand?
6	3a	5	Many people can be motivated by reward and punishment. It is better to give me extra feedback instead of oblige me to look at the screen all the time. In that case, I wouldn't need to check the road and it would cause motivation.
7	3b	5	That is definitely important and we don't have this today. I regret all day to wear something instead of other and I can't change my clothes. It would be great if it says something like "wear thinner jacket" or "don't forget to take a jacket". Something should remind me this.
8	4	2	It might demotivate users. I can't help it I need to go to work by car. My carbon foot print is probably very high. If this product reminds me this all the time, I might not use it after some time. Maybe better to change the language. For example, "Oh you mostly walk this much kilometres. Don't you want to walk today?" It is more positive. But if it only notifies negative stuff, it might annoy me. But again, there are some people who might motivate with this. It also depends on characteristic of user.
9	5a	5	I think giving priority to sustainable mobility options quite supports the objective. Existing applications for transport suggestions, give priority to car and bus options. Maybe not in my home town, but especially if I went to some other country or city, I would like to tour the city. If walking and biking options were more visible in the interface, it would be clearer and more preferable for me. To see the reward how much calories you can lost is actually better.
10	5b	5	Before, I didn't really pay attention, but especially after pandemic and online shopping, user comments get higher importance for me. It is really good to see other's comments and suggestions. Plus, if the suggestions are sustainable, it is better.
11	6a	5	It is really nice. I've met people who would be die for this. My brother went to the gym only once. And he participated the spinning classes by a chance and they told them that they will give tshirt for the ones who stays till the end. He couldn't walk for next 3 days but he has the tshirt and he was proud of it. Reward highly motivates people. If we can get free ticket and such, it is 5 for me. It can be not only free ticket but discounts, or trial opportunities for bikes maybe. Maybe user can set a goal and try to accomplish it, not only the system suggestions.
12	6b	5	It could be. Are these suggested restaurants offer healthy or vegetarian food? It shouldn't be limited. Maybe I can ask for suggestion. It can be better without waiting for the app.
13	7	4	I feel like I won't take it off this wearable, I would wear this in the morning and it would stay. It could be a bias also. I wouldn't consider to make the screen bigger. I wouldn't prefer to open it and make the screen wider. To see and be informed by single screen seems easier for me. To look inside of the palm is not new for us. We hold our phones with similar gesture. So it is not that hard to see the screen on the palm. Your age and habits change this also. When people are in a rush, then it might be good as alternative to have a wearable on your hand. It could be bracelet.
14	8	5	Wireless charging existed even in 2015 maybe. IKEA had smart furniture in 2013, I suppose. There is a surface on furniture for your phone to charge. You just put it on. We are talking about future. This is not impossible. We started to touch screens with I-phones in 2011. Our interaction with mobile phones changed recently. I don't think this is far away. If my fridge can order milk for me, this can happen for sure
15	9	5	Definitely 5. There's a transportation card in our city and you can download its app and charge your card. If I want to use scooters in the city, I need to download a different app. So, it is frustrating. This wearable definitely facilitates the other sustainable options.
16	10	2	This is a bit too much. I mean for example, the main concern for autonomous vehicles is how they will make interaction. Which vehicle is going to have the priority; the one's owner who is richer than the other can give signal and pass? Since autonomous vehicles have no human control, the danger is more perceivable and inhibitable. But here, it might be difficult to make calculations since both car drivers and bikers are human. I'm not sure really. User will be in action so it might be difficult to perceive the vibration. Maybe the warning could be more visual, but also, we need to see front while biking. Warning could be via my earphones, so by audio. Bikers can also cause harm. This could be thought in reverse. So, my wearable can warn the car driver. Your sketches are 2D so it might not be the same on real hand. The information you put on the screen on your hand might not be clear to see. Some part of the screen will be invisible because of the curve of your

			hand. I am not sure if I make this move of my hand. I may not look inside of my hand for more detailed information. I just see the notification outside of my hand and it will be enough for me. Maybe you should consider to solve everything on the face of hand not inside. We are more used to look one screen, so I might not think to turn my hand for the second screen. What if to use hologram technology to avoid the curves that may cause lack of visibility of screens? Or instead of information on screen it may give information by earphones. I may not use this product in the way you suggest, I might try to hack this. For example, wearing it reverse or rotate the bigger screen on my hand not in the palm... Our habits since today is to see only one screen. We don't need to change it, only the screen itself changes. This is really a good example of research through design. You constructed a future fiction by some documents, reports and analysis. Then you talked to people and created personas and finally proposed concept design. I felt like you considered so many things so I don't have more suggestions apart from we talked before. It is also hard what to expect from the future. But I can say that this is a well thought project. Congratulations.

E2 *1984 – Interaction design – Design and Innovation (PhD) – Assistant Professor, Researcher*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	3	It is tough. This is probably flexible. I can say that it avoids body proportion because it is on wrist. But I am not sure on gender difference level. Maybe women can be eager to wear but men might not prefer to wear. Or women might not want to wear. Because the product covers quite amount of surface. It is not a small device. Maybe personalization can solve different gender problem. Our hand size is also different from each other. You have to consider ergonomics. You need to be aware of the difference to design this for 5th percentile female or 95th percentile male. You can produce this in size like small medium large. While we are buying bike gloves, even though they are elastic, there are different sizes. Or you can make fixed measurements on screen part but use elastic or changeable details on the connection part. You need to work on this a bit more. I am not sure if I wear this in summer because it is hot enough. The screen part can be adaptable. So, I can use thinner fabric in summer and thicker fabric in winter. How am I going to use this in winter, really? On my winter gloves? Because my fingers might get cold.
2	1b	5	You will be designing a family here? Yes, I think this is a good solution. If I don't want to wear this on my hand, I can put it in somewhere else.
3	1c	4	I think this is more suitable. I am not sure about unisex look really. Size options, flexibility make sense. I don't think that opening up the glove is a good option. Users will be using this while they are in various actions. So, they might not think about this feature. If you can use this product when unopen, then it might be ok. I think small options are good but yes, small screens might be a problem. I think small sizes are better for the concept objective in terms of gender and body proportion. But we can see more information in bigger sizes. They have both advantages and disadvantages.
4	2a	5	Ok then you don't design the glove but the whole system here. We have glove and we can wear anything we want including in this system. Yes, ok then this is good. For example this solar fibre part comes with the system and do I attach this on my clothes?
5	2b	5	I think it is better to separate the smart part, technical part from the glove. I can purchase any colour, any fabric here, then I can attach the screen. Or we can consider this like watch and its changeable strap.
6	3a	5	Is this only while walking? It gives motivation. I don't need to check google maps to understand how much time left which is good. It can give feedback in every 5 min or 10 min depending on your route. This should be optional also.
7	3b	4	I am not sure about the motivating part but this could be a good guidance. Maybe it can give extra information apart from this, like If you want to walk, you need a coat after this time". The guidance text could be more specific.
8	4	5	This is not for motivation. Because it somehow blames you for your actions. This could be ok but maybe also the things you achieved in a sustainable way. Or could warn you for other unsustainable behaviours in city life except from mobility. For example, recycling or other.
9	5a	5	This can cause a motivation.

10	5b	4	Is this related with sustainability? I have doubts. This could be sustainable goals. Not any goal. I don't really get why system does this, like local stores and such, I don't know.
11	6a	5	You can consider rewards for other sustainable actions maybe, if you don't have to limit this with mobility.
12	6b	1	How could this be gamification? Provide reward for desirable action? Only points? I cannot see any reward here. It doesn't match with objective. "If you go to restaurant one more time, free meal" maybe something like this could be a reward.
13	7	4	I am not sure about the position of the wearable. You may not use your hand like this. It satisfies the objective. But if I take this off, then how am I going to use this fabric? Do you think I can see the screen efficiently? It depends on the durability of the screen. When I tap or do some other gestures it should not slip. I am not sure about the usability but the idea is good.
14	8	4	Yes, I think it satisfies. Does it need to ask? It can directly charge itself. It can show the clothes I wear that day. And it can ask me which one I should connect. Or it can connect to any of them without asking. It can also connect to someone else's jacket. So, I think I need to register my clothes when I buy something? It can be automatically done.
15	9	5	This is like contactless credit card. Yes, it highly satisfies.
16	10	2	I am not sure if it provides security or distraction. If I use bike or run, this is definitely a distraction but if I walk maybe it's ok. You might solve with audio but it might be scary also, could be light. The clothes I have might change colour as a warning maybe. This could be dangerous you might have an accident while biking.
			Notifications should be filtered. For example, if I am out of my city I can ask for being notified. But if I am in the city I live, I should be able to cancel this. Or if I go out for discovering my city then I should be able to turn on this. Some features are also phone feature. Does it really bring novelty since we are talking about future? Hologram technology can be considered. When I pass through somewhere my clothes colour is changing? I am not sure about the position of hand in your sketches. Because in regular position, some part of the screen might not be seen properly.

E3 *1989 – Healthcare textile design – Textile Engineering (PhD) – Research assistant*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	4	This glove is like an alternative for smart watches. I think the half glove's design looks nice. What about a bracelet with wider straps? But the position of the glove might be better while using the screen. What do you think about a bracelet? Wider strap and you can wrap it 2 times for a wider screen. But also, I think this is also useful for bikers, athletes or another sportsman. To have something on your hand. But again, you can go for bracelet. Since it will be a fabric and lighter, and fully elastic screen, it can be preferred more than smart watch.
2	1b	4	You need to decide the closure types for this modular piece, could be Velcro maybe? Wearable might have 2 layers. I can open and close it on any part of my clothes like latch. You can use magnets or other sticky material. You might turn this into a pocket, users can use it as a badge and they can write their names while going to a meeting. But to put on sleeve, no I don't think so. But maybe inside of pocket or fastened to pocket.
3	1c	5	I think the 1st option without finger support could be more practical. The smaller size of it might be better for daily life but wearing something that wraps fingers is a bit uncomfortable. We get used to wear things on our wrist such as bracelets, watches so we don't even feel them. But these small ones, I don't know. It might be heavy related with the material also. It is possible to create a fabric that functions a flexible screen. They are already working on this even they created fabrics that function as touchpad on sleeve. You know Levi's and Google's project. It is definitely good to have size options. Everybody's choice might be different than other. Or user might have a disability or injury on wrist so they may choose small sizes.
4	2a	4	I think this should be sold with a kit including the clothing options. So, you can design the clothes that can be modular with this. Or at least you can include the closure materials or exterior sensors instead of this single glove.

5	2b	4	You can design a case for the glove, like a layer. So user can change the layer and add different colour or pattern. In this sense, they can also protect the electronic part and customize it at same time. You can use basic colours and user can only change the non-screen area like a watch strap. Also, you can design the glove with full screen. And screen colour can change anytime you want. It is good to have options but also better to go for more basic colours like white, black or grey. Because they will be using this all day and it needs to fit your other clothes. And you can produce fancy options less than other. If you consider kids, you can go for more colourful versions. It is also hard to perceive technology and recommend something. Maybe after 10 years we will be using products that we cannot imagine now. Before, the smaller phone screens were acceptable and better. Then the smart phones introduce and first I was a bit distant. I thought I couldn't even fit this in my pocket why should I buy. Now, we get used to it and I have wider screen. So I'm sure, we can get used to this product after a while.
6	3a	5	I think these kinds of feedback are pleasant. I use an application for running and it says "Smile, you've burned that much calories". Even though you know these texts are automatic, it motivates you.
7	3b	4	I think this is nice. But is this connected to phone or functions solitarily? You can use this wearable instead of phone, then… This wearable can be also used in a factory for employees also. Instead of using computer or other devices, merchandising departments might use it.
8	4	5	I think this is motivating. Sometimes we say "Oh, I didn't do anything today" but you can find out that "Well, actually I took that many steps." It is better to see more details of what you've done and might persuade you to act differently. Of course, it depends on people but still this is important to be aware of.
9	5a	5	It is nice to see sustainable mobility combinations.
10	5b	5	It should not suggest me the places I've already been. Since it has a GPS and knows where I've been. Maybe it can give me different data for the places I've experienced before like discounts, for instance.
11	6a	5	This is lovely.
12	6b	4	This could be tiring. Being notified all the time… Maybe I can filter the data I would like to get. For example, to configure it to show me only seafood restaurants.
13	7	4	Can I wear the same glove on my right hand? You should consider left-handed people. Or you can produce this with a double-sided screen. You can place a material under the screen that stables the soft fabric while on opened screen. It is nice to have an alternative. You can roll it and put it in your pocket if you want. It is better to keep or hide the fabric-phone when you consider its volume.
14	8	3	Solar fibres are not that complicated any more. But I think it is better to attach the solar fibre module. Not to have this in your clothes on default. Or you can consider other accessories as a solar resource, like necklace. Can't it charge itself with its own solar panel?
15	9	4	This is really practical.
16	10	3	It could be nice. For example, Volvos have this sensor in front. The car immediately stops when it sees someone's crossing the road whether you brake or not. So, cars might use these sensors in the future. In that case, you don't need this. For the vibration, you can put modular electronics and you can take it off when you need to wash the jacket. But again, in the future we might produce washable electronics as well.
			I think this is useful. I would like to know the popular restaurants and rankings. These features must be optional, otherwise being notified all the time is annoying. There are small batteries in the size of coin. This is today's technology; in the future you can solve this without any wires and more tiny batteries hidden inside. There will be a friction inside of your hand, while you are holding handlebar. So, you may consider additional transparent layer like a case. You can put the layer while on weaving procedure. But it is a fabric after all, this can be damaged. But in the future, this can be solved also. User can wrap this half glove in a desired way. It has a thumb cut and one can tie this in other positions. Maybe you can provide this option that you can wear this on your wrist like a bracelet, but if you wish you can use it as you proposed on hand.

E4 *1984 – Fashion Design, Modular Fashion – Fashion design (PhD) – Associate Professor*

CO	CS	Satisfaction Scale	Expert Statement

1	1a	5	Wrist area is a good idea to avoid body proportion. For example, after pandemic we pay more attention to wash our hands. We try to avoid to touch some areas. So how do you solve the hygiene issue? Why did you design a glove instead smart watch? You touch everywhere with your hands so the glove can bring hygiene issues as I said. I don't have concerns with durability but just hygiene.
2	1b	2	Maybe user prefer to attach on sleeve but other parts… Imagine that I have text message, I cannot see if I patch this on my neckline. Maybe on some parts where I don't lose eye contact.
3	1c	4	It depends on the data. What am I going to see in that screen? I would definitely not prefer the small versions. They can easily slip. For instance, it looks chic but I would prefer watch if I have smaller screen.
4	2a	4	This might not be related with fashion because you don't offer colour, pattern or shape change. But the system idea is ok for me. You can turn this wearable into zipper puller. You can fold and use as zipper puller.
5	2b	5	Have you seen E-ink? It is a flexible display that looks like paper, and you can change the colour. In that case, you can buy one option, change the colour as you wish. You can even draw your own patterns. They also designed sneakers (Shiftwear) that have customizable e-ink. The display was animated and this was years ago so this technology must have been evolved.
6	3a	5	I think this helps a lot.
7	3b	5	It can also suggest accessories like umbrella. Not only clothes.
8	4	5	This also satisfies the objective. It works.
9	5a	5	This is also nice.
10	5b	4	I feel like there are so many guidance, information. Is it too much perhaps? Maybe better to limit this. Or user should be asking for information.
11	6a	5	This really motivates user and encourage them to gain more points.
12	6b	4	Too much suggestions might make user feel stupid. For instance, if I want to go to a museum, I don't need this wearable to suggest me this. I can think on my own. It might be better if I'm out of my country or tourist. I wouldn't prefer suggestions in the city I live. It might confuse me.
13	7	4	I might prefer to have this instead of using phone. It can facilitate my life. Without taking out my phone from my pocket, I can use this glove.
14	8	5	It is nice to have an option to charge this with something that you carry with your body. Maybe people can check their city map to look for wireless charge stations. They can walk to the stations so this might also encourage walking. You can think to design this solar fibre parts modular. If it fails somehow, then you will lose the whole jacket.
15	9	5	This definitely satisfies.
16	10	3	This might frighten me or stress me while biking. Maybe better to warn the car or car driver. My clothes can change colour like a reflector, so that it can warn the driver. It is better to change colour rather than vibration. The worst part is the vibration.
			Solar fibres might be located in accessories like zipper puller or buttons. You can design a cover for buttons and use it interchangeably with your other coats. Your design is a good fashion product. I think it can be sold by large mass of people. But it also depends on the fabric, quality of fabric. Leather fabric can be very chic. Could be denim, maybe. You can go for narrow woven fabric that has a textured surface. You can add some other parts on wrist part, like rib knit to make it more sportive if we need. This product's main objective is functionality. So, sometimes aesthetics might have secondary importance. For example, I'm scared of dogs in the street and I change my route to avoid them. So, this wearable can also send some kind of signal (not in a cruel way of course) to distract dogs.

E5 *1991 – Vehicle Design – Industrial and Vehicle Design (MS) – Industrial Designer*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	4	This looks like it can fit in any size. You may not even need S-M-L sizes if the form is like this. I used shared bikes in London, also tried scooters. It is really impossible to use your phone while you are using them. So, this wearable which is located on wrist and hand area, looks like a good idea for me.

			If it provides all the functionality that mobile phone has, it can be really convenient for me while I'm in the city life. Sometimes I sit in one of the seats in metro and seats are mostly too close. And you can't even take out your phone from your jean's pocket if someone sits near you.
2	1b		I might not want to wear this all the time so it might be a good idea. But since it is very thin layer, also I can fold and put inside of my pocket.
		3	If I want to wash my hand, I need to take this off. So, I can patch this on me at once.
3	1c		I think it is better to be in wrist area and has larger screen on your hand. It is logical.
		3	Instead of preferring small options I would prefer smart watches. Since the size of the screen might be more or less the same. I'm not used to have something on my finger.
4	2a	5	This glove cooperates with other clothes so when I wear this, I don't need to wear a single jacket. Yes, it is a must.
5	2b		I like to wear watch as an accessory for instance. I would prefer them to match with my shoes or belt. So, this glove should match with my clothes.
		5	Leather material could be a nice option. So that I can use it with a suit or casual wear.
6	3a		I wouldn't prefer honestly. But if I design this, I would do the same.
			I don't like to be guided. It acts like a human but I know that it is a machine and this bothers me. But other people might like it.
		3	Some people might not prefer to check how much time left, but want to hear the notification like Siri.
7	3b	5	This definitely satisfies. It is hard to guess weather in the morning so it is nice to be informed about this. It makes sense.
8	4		I think it can give more detailed information. For example, "You took a cap for 10 min distance". Because sometimes you have to choose unsustainable choices. So, it should not warn you for all. If I use taxi unnecessarily it can warn me.
			You can think about positive information also. For instance, "Well done. You didn't use your car today"
		4	This can be annoying at some point if I don't change my habit but it continues to give me data.
9	5a		It might work. Current apps only give combination for walk and bus for instance. Not bike. So yes, it is logical. But I am not sure if it creates goals.
		3	It could be something like, I am sitting and it says ok let's go for a run. You sat a lot. You should move.
10	5b		I wouldn't prefer this. This might disturb me because this is tracking and it knows where you are. So, it is like sharing your personal data. This is part of our life now, and I am not sure about the future. But I don't
		2	know some things might be arranged.
11	6a	4	Yes, it might work. Besides it encourages you for healthy behaviour so why not? Yes, it is good.
12	6b		Maybe this system would be anonymous so you wouldn't feel insecure or be chased in the future. If I know that no other company or government or anyone can reach this data, then yes, it is ok.
		3	Do people ready for this? Z- generation might be more comfortable with this data sharing.
13	7		I think it is very logical. And the reason why we don't have this is we don't have enough technology now. There are flexible screens but if it offers same speed, same resolution I would definitely want something like this.
			I can prefer implant wearables like my hand is the phone itself.
		5	So, I put this on the table, I need to go somewhere else and I need to hold it and try not to forget it, or put it inside of my pocket. But if it is tied on my hand, then I don't need to think.
14	8		It depends on how much energy it needs. There are some watches that you just need to move your hand and it charges itself with that kinetic energy. And it is an old technology. So, some other solutions can be
		5	thought in the future.
15	9		You can also use your phone for this.
			There are different movie and tv series platforms like Netflix, prime, or other that you need to subscribe separately. But the content is more or less same and they unite different platform's products. It is not impossible to unite all these mega platforms. And you can consider the same for this. It is not that far away and it is a must.
		5	Also, it is not a good idea to monopolize the systems. But there are lots of alternatives so the idea should be only to see different companies at the same interface.
16	10		Why don't you consider to warn the car? Cars are also getting autonomous. So, as an outcome of machine interaction, they will be able to understand the biker or pedestrian nearby.
		4	Electric cars are also very silent. It is almost impossible for you to understand there's a car nearby if it is not on your sight. So, the warning is not useless. And vibration wouldn't scare you, I think it is logical.
			I also designed autonomous vehicles for the future, 2050s. We were designing as a group of people and we assume that technology can solve everything. It is tough because then you can fly. So, you should find the balance. The meaning of not worrying about technology is actually its relation to software and coding. Anything can be coded.
			The most frustrating part for this smart future is the battery technology and physical boundaries of human. But software technology is evolving so fast.
			Everybody was foreseeing flying vehicles in the beginning of 2010s. Now, we have more secure cars, less gasoline waste, embedded technology but still don't have flying cars. But smart cities, integrated systems,

			IoT is growing and evolving faster.

E6 *1967 – Textile Technology and Sustainability – Textile Engineering (PhD) – Assistant Professor, Researcher*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	4	I think I need to try the fabric. Normally, bikers use the gloves with finger parts. In this one, you have only one finger support so it can come off. You may need one more support in last finger maybe. It seems very easy to use. You may add knitting fabric on wrist area.
2	1b	2	It is very interesting. But if it is modular, what is the system you put on the jacket for instance? Do you think press studs or Velcro? If this jacket is leather, then Velcro might not be a good idea. You should change your closure type regarding the fabric. Are you going to develop the jacket for the project? Or can I use any jacket in my house? Maybe you should work on the technical detail here. Because it is not clear.
3	1c	5	These small wearables will have connection with phone? Does 3 and 4 have a specific function? 3rd and 4th versions don't seem like they have a purpose. They are also not glove anymore. 4 might be interesting, but 3 is very small and it is hard to understand the function. Instead of using small ones, user may prefer to use bracelet. In terms of usability, when I am with bicycle, it is more interesting the solution 4, comparing to a bracelet. Because it is on my hand. But also, it can easily slip so you may need an extra support. But if it is like second skin, it won't slip. 1 and 2 could be good for winter and the small ones for spring.
4	2a	5	If I have the glove and I have control of the system then. It is good. You can also connect to other accessories like backpack or sneakers.
5	2b	5	I think it is important and same as the masks we wear right now. You can have a base and you can cover it. Maybe you can add fluorescent piece to see for the night. Pattern is important also. You can add business. It is important to customize.
6	3a	5	Mobile phone does the same thing so the question is why should I have this instead of mobile phone? Yes, maybe in the city centre I don't want to show my mobile phone because someone might take it. It is nice to have something on my hand. Maybe better to clear the instructions. You can add a map or destination details.
7	3b	5	I only didn't like the icon. Maybe the visualization might change according to the garment type. It is also better to give more details like giving weather degrees every hour.
8	4	4	It gives information not in a positive way but in a negative way. I think it's a good idea. I think sometimes it is better to give information to someone that they are not good enough that month. It is good to remind people.
9	5a	5	You should also give specifically sustainable suggestions not any suggestion. Sustainable option is biking, walking, but losing calories, I am not sure if it is related.
10	5b	5	These playgrounds and local stores should be related with sustainability. This system should not promote user to consume more. For the restaurants you can add vegan options. So, the suggestion should only related to sustainable options. Because this is your objective.
11	6a	5	Very good.
12	6b	5	As I said it should be vegan food or natural homemade food. You can associate with some other companies for food service like Uber or Glovo. They can ask food for online.
13	7	5	So, it is a flexible phone. Instead of using your mobile phone you have this. Yes, nice. But maybe better to have an image for real flexible screen. For example, some famous phone brands have already had prototypes for flexible mobile phone, looks like paper. For the future, people would use it if it is flexible and comfortable enough.
14	8	3	It's good. You have to work on the technical part. You can use wireless technology but in order to use it, the glove should touch the garment. You can use solar fibre fabric not only back but also front. Could be a pocket of the jacket. Could be in the belt of the jacket. Solar fibre belt could be more interesting. For example, you need to wash the jacket, you can easily take the belt out. But in the future, you can wash solar fibre fabric. It might be better to have solar fibre in back while you are riding a bike. You can consider these fibres on hat.

			The last time I was in Frankfurt in technical textiles exposition, they have already had some yarns to do battery charge. They designed backpacks. You can consider backpack also. Solar solutions are not washable today. Conductive yarns are washable for instance but the problem is the stability of the connectivity. Battery issues will be solved as not better systems to charge the battery but better batteries that don't even need to be charged in the future. There are currently places to charge your mobile phone outside today. So, the solutions might not necessarily the jacket but also some stations in the city that you can charge for 5 minutes in the future. These charging platforms might be placed in bike stations. Of course, I prefer to have battery for all day, and to charge with something that I have with me. So, I don't need to stop for charging. But also, in the future, I don't know, these might be solved in a different way. You should also think about human health, if it is good or bad to have batteries in your clothing.
15	9	5	This is a good solution. There are different cards I have in my purse. To have it all in the glove, this is very good.
16	10	5	Maybe you can give more details like a "Car is coming in 3 meters" for you have time to action. I think this is very important. Because in the future, cars will be electric and they don't have a noise. So, in the future, this will be very important. I think it should not be the jacket which gives vibration but the glove. Overall, I think it is good.

E7 *1972 – Industrial and Space Design – Industrial design (B) – Designer, Lecturer, CEO of Design/Consultant Company*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	3	I think the product which is located in the wrist area is discomfortable because we use our wrist a lot during the day. If we think about 2030s maybe the habits of people like writing, using pen or craftmanship might change. In that case, it could be possible. It would be discomfortable for me. I use watch but I take it out time to time. If it is located in wrist area it might limit the movement even though the material is flexible. It looks like bandage. If the product will be like billiard glove or half gloves to avoid deforming the drawing in tablets, I feel like it might be disturbing to wear all day. Also, you should think about hygiene. Because pandemics like this will continue and might repeat every 4-5 years. So, we will be in need of hygienic spaces so the glove like this might not be a good idea. Did you watch Total Recall 2012 version? There was a future product like this. The year must be 2047. Not a glove but directly integrated product on human that you can reflect to a window and turns it into a screen. So, they created this type of concept that you can check. In the near future we still probably need the screen. When we were kids, we watched movies with technologies like hologram as future concept. This reminds me something. We had old TVs with CRT (cathode-ray tube) technology, then LCD (liquid-crystal display) technology appeared. Even though those LCD televisions' resolution was poor and not visible from every angle, people bought it. Now, their resolution is much better but transparent screen has also emerged. Here, if a screen is transparent and shows back, this means that resolution need to decrease. If not, then it might have an advantage. Flexible screens are also emerging. For example, even solar panels are going to be flexible and transparent. It looks like a glass but is able to do the radiation. All in all, when we think about all these technology process, we will still be in need of screen in 2030s, 40s. But further time, I don't know. Today, it looks like the distant communication requires face-to-face meeting. So again, for the near future, with this physiology, we will need screens.
2	1b	5	A product which is wearable, quite restricts you. Both jacket and glove are wearable. If you say for everyone and every condition, this glove should be attached in summer and in winter as well. If we have a screen, then it should be attached in arm area for us to see. But we don't need a screen then it could be anywhere on body. Now, people are looking at phone screen all the time, but I think that habit will change after 2030s. In that case, maybe we don't need the glove/screen to be on our sight all the time. There are smart necklaces or bracelets. So we might not need a wide screen in the future. Important part is the feature, what kind of information does it give, what is the expectation? Is it because of the battery technology, or use solar energy? Could it be smaller? Why do we wrap it on our body? If we do it, it should be a breathable material, washable and hygienic. Does it have a camera for instance? Or does it get any data for touching some surface.

			Do we still have a mobile phone in this concept? Why don't we have a hologram coming inside of our hand if we are making a concept for the future? Hologram is a very old technology. Before, we needed a reflective surface, but now with laser technology the requirements changed. In the beginning of 90s, mobile phones were huge and heavy. Then phones got smaller and in 2000s motto was like this: The smaller the phone is, the better or more modern it gets. People were boasting about their phones' small size until smart phones were introduced. Now, phone screens are getting bigger and even hard to carry. Samsung introduced Z flip phones which have foldable screens and it is possible to make it smaller again. It seems like the wider screens are inevitable. Why its screen is rectangular? Why don't you use all the area as screen? This wearable can be considered as motorcycle buff. You can wrap it around your wrist or use it as mask to cover your face or neck. You just need to make it smart.
3	1c	4	Gloves or glove-like products are for using hands. Why bikers wear gloves? Because it has soft pads. Decent biker gloves are mostly fingerless and have non-slip pads for palm where you touch handle bar. Gloves need to tighten your hand to slow down getting numb. In the outer hand area, there is a terry towel so you can wipe your forehead. They are adjustable. So, biker gloves have multiple parts and fabrics. I try to emphasize its functionality. Another example, industrial gloves which workers use for avoiding crush, hot or cold conditions or other conditions. But now you design something technological and the only meaning is to wrap a screen on our hand. This is not enough. If you say this is for bikers and have this functionality, then it's ok. If it is for everyone, I don't think it is right. Especially when I think about summer. Or all these versions might be designed as modular and you can add or remove the peace according to weather or need. I am not sure about the size. For example, my hands are big. If you standardize the screen size, then it might be a problem. You should think about the rectangular screen shape, LED screen technology consists of pixels so it might easily be flexible in the future. You can think different shapes of screen. There are watches that covers your wrist immediately when you touch without using any connecting stuff like Velcro. It is only for wrist area but you can consider. 1st option is more logical than others. 1 or 2. How will be smart phones in the future? If they provide something better than your concept can collapse. How will be the communication technology in the future?
4	2a	5	Sure, it is a good idea. Clothing is expected to be smart in the future. I think the most obvious features that are expected from smart clothes are being wearable in every weather condition. They might also measure temperature, stress or even our mood. In this sense, all these clothes need to have a screen to show their data and gloves might be good idea to be that screen.
5	2b	4	We met with masks in our daily life a year ago. They were white at first then black, other colours and even patterns. Of course, you should go with the colours that might be accepted by majority. If it is something that is technological, I would like to see it as technological. I mean I don't think it should be leather. When we look at future concept scenarios in movies again, most of the time heroes wear white, or light blue, light green and details are black. Spaces are mostly light colours. Not pure white but metallic or light reflections. So, if I design something for future, I wouldn't prefer to use a material that looks cheap. Black colour in hand is very attention getting. So, users may prefer it as skin colour or more tech look. But of course, other may want to look different. Maybe this can change according to user's skin colour. Every human colour is different so this product can copy that skin colour. It is inevitable.
6	3a	5	I think this is motivating. In pandemic case, first they announced as lock downs will be for a month, then after a month they announced again a month more. They didn't begin with 3 months. It looks same for me. This should also provide guidance for the target point. It can even start to play a song "Eye of the Tiger" for you to speed up.
7	3b	5	Well, this might not be necessary in Netherlands for instance. I even saw a woman riding a bicycle with her fur. So, it depends on the culture also. Yes, but it works for countries like us (Turkey).
8	4	4	I had a smart watch that notifies me for my sleeping habits like you went to bed late, you should sleep earlier, you walked this much. I didn't buy this product for this reason but it gives me these data. Similarly, a bank application notifies me for my purchase details. Normally, I don't want to be notified about these issues, but when I see them, I try to change my habits. So, these kinds of things really have power to motivate people. Maybe I prefer more positive feedback like you can do it, you can do better.
9	5a	5	These are important. Every product will be tracking us for everything so it seems like inevitable. These kinds of notifications are of course good. You can advise for loosing that calory and also deserve to drink one cup of beer or one bar of chocolate maybe.
10	5b	5	Of course, 5. But most of the applications and your mobile phone has already been doing it. These are all

			related with application. But the most important thing is how to wear it or where, in which condition. What kind of technology? The screen must be unbreakable. And people should trust it. If the product has 100% efficiently working technology, enduring, and ergonomic then these kinds of application details are easy to do and inevitable. Any firm can work on app, interface side if you design a good product. These are all interface. How do these kinds of features effect the form of the product? Is this product ergonomic? Hygienic? What about battery issues? Is this durable and trustable? I buy phone covers immediately to avoid cracks. These should be primary questions. On the other hand, if you use Velcro for this, Velcro material can easily get dirty. So, are you going to use magnet? The edges of the wearable should not be sharp because it looks like it might harm the skin. It should be more concave. Also, this product is for right-handed? Then the screen can be used for both sides. Or you can change the design for both hands.
11	6a	5	It could be good. Even now you can share many things via apps or social media. So, there is no reward but competition. If you provide tickets and such it is better. Or maybe discounts for bikers or tax payment. This reward system is better than other solutions.
12	6b	4	If you can adjust the settings for notification it won't be annoying. Everyone is looking for comments before going to a place and buying stuff. So people have habits. Maybe this wearable can be a product that you can rent as a tourist when you rent a bicycle. It would be great! Imagine it notifies you and gives feedback for all the things you might do in the city you don't know.
13	7	5	If you have mobile phone, then do you really need this? If this project is a near future project, it should provide an alternative for mobile phone. I think mobile phone can be a wearable. Why not? It is inside of our life and it is fragile so why not to transform it? Our conversation habits are also changed. Now we are sending photos from apps, or video calls instead of simple calls. So, phone, calling part might be evolved into something else. I might not need a phone, smart phone to communicate. Anything smart can provide me smart phone feature. I don't need my phone to approach my ear because I have wireless earphones now. It might even be an implant in the future. I think this foldable and touchable screen that has smart phone features would actually really satisfies. So we don't need a smart phone anymore. If we talk about future like 2040s maybe, then we won't be using tablets or laptops. We may have this peace of fabric roll and unroll it and make a wider screen with embedded technology. Why not?
14	8	1	In our time, the direct sun interaction increases the efficiency of solar panels but they also work just fine in cloudy weather. In the future, the efficiency of this system would be much better so you wouldn't need a special place like this. There is a wireless system for charging now with a magnetic field. The future concept for electric cars is also designing them without battery. Because the roads will have a magnetic field so they can be used while on road. If it is future, then there will be no issue related with battery because the battery won't be dead. Of course, the disadvantage of magnetic field is not being good for human neural system. Of course, these are very low energy sources. So it doesn't necessarily need clothes for energy it can be anything in the city or house. Or even product itself might have a transparent solar panel.
15	9	5	Of course, it satisfies. If it replaces our phones than it is logical.
16	10	4	When they first designed autonomous vehicles, the main problem was the system couldn't define if the object is building or truck. But they improved many things. For example, in warplanes there are head-ups. All types of planes have different colours. Cars have this head-up system now. Since the cars will be smart in the future, this system might give warning to cars and driver can see on their head-ups. Also, it might be hard to sense which side is vibrating if it is not stretched. Besides, how many vibration motors you will need? And also we have wireless earphones so it can warn us in vocal message. Also, people may trust the wearable and if they cannot feel the vibration, it can cause more accidents. You should be careful about the location of the product. For instance, I wear watch all the time. When the season changes from summer to autumn, I notice white unburned part of my skin under the watch. This product also covers hand and wrist so is it permeable to UV light? You expect this product to be with you all day. It might cause allergy to the user or it might smell. It also needs to be durable for sanitizers.

E8 *1987 – Software Coding, Computer Engineering – Theoretical and Mathematical Physics(B), Web Design and Coding(B) – Software Test Analyst*

CO	CS	Satisfaction Scale	Expert Statement

1	1a	4	Actually, in 2010, Google made Google Glass product which seems like more or less a similar version of this product. Instead of glove, it was glasses which is another type of accessories. The idea was more or less same but there was not much demand. Because it had an unsatisfying battery unit and it couldn't meet the expectations. Even though it was Google which is one of the biggest companies in the world. It was not about the money but the technology. In today's technology, they can do much better and may able to meet expectations. This glove has the same issue. If there is adequate technology, why not? This wearable has a thumb hole and larger part of the screen is on the palm. What do you think about the durability of it when you hold the handlebar of the bicycle? It may damage easily because of the pressure. When you use bicycle or motorcycle, gloves' inner part mostly deals with a serious force. There should not be any circuit element inside of it. Maybe you can think about the screen part or put more solid texture to absorb the force and protect the circuit. For example, in weight lifting gloves, there are soft padding parts inside. Maybe not like that but you can consider similar. The materials I know for bullet proof vest for instance, is only to prevent instant impact not constant ones. Bullet proof fabric doesn't let the bullet in but it transfers the force. So, in that case, you may block the instant impact with a simple layer but I am not sure about the constant pressure. But yes, the idea is good. Whatever I wear, under any weather condition, when I do sport or even swim, I can use this glove. An old man can use this without putting his hand into his pocket which is good. The main reason why these types of wearables are on arm or wrist area is the visibility and safety. Hands are not always clean or stable. For example, if I stumble and fall, I try to find my balance with my hands. And I ruined my precious expensive glove. But if it was on my arm then this may have not been a concern for me. Could be even a ring. Something located on your palm may restrict your movement. And another thing is, do you think this can cover my hand perfectly? Because hand has curves. This one with no finger support, the upper part of it may curl and be uncomfortable for you. If there's another finger support you can divide the force equally. But the other one can easily slip from the hand.
2	1b	2	There are magnets called Neodymium which are tiny and pretty powerful. Those might be used for the attachment. So, they are not natural magnets, in other words lab created. They are so thin and are able to carry many kilograms. If you embed these tiny magnets inside glove and garments, you won't even need to fasten. They immediately cling when they are close. Velcro, zipper or snaps need both hands. Imagine that you need to take the glove off immediately, magnets are faster. Magnets can also be harmful for the circuits inside of the glove. But there might be other ways to cover or avoid magnetic field. Here, magnets change the electrons direction inside of the circuit elements and this affects the current. If you block the magnetic field problem can be solved. But of course, I am not sure if it is worth for R&D. Since we are talking about future technology, it seems like all of your clothes or accessories will have embedded circuit elements. Maybe you can exclude the valuable components of glove like processor, micro-controller or screen driver and keep it in safer place. And you can transfer data to glove by wireless. In that case, you can use this little magnets or other elements that you consider harmful. In the future, you can solve this. If you use zipper, I would say "what is that? It's 2030s and still zipper?" Maybe magnets are also not the best solution but you can solve this in a better way. Is the only reason you attach them for avoiding hand wrap, or do they have different feature together? If glove and jacket meet and creates something different, then ok. But if not, you can just put inside your pocket or backpack. Then it seems like useless.
3	1c	3	I think the best one here is the option 2. If a product or any object is located in the most dynamic place, it must have a support from 3 points at least. The best example is here is safety belt. The dynamic object here is human. In an instant accident, you can be driven away. If it only fastens from 1 point, it won't work. In your 2nd option, you have thumb support, point finger support and the closure part support. Therefore, it has sufficient support. It won't be off your hand; it won't widen and no other object could be stuck between glove and your hand while you put your hand inside your pocket or bag. Option 3 and 4 seems like impossible to locate them in that area. Imagine that you have something on your 2 fingers it can easily slip. Non-slip fabrics or layers may not work on a joint. Because they cause friction to prevent slipping and it surely prevent moving of that joint and cause discomfort. If the material is elastic, it may help but I don't know. If I were you, I would pick the most efficient option. Then provide option to people for customization from one form of design. 3rd and 4th options are the worst, 1st option also doesn't have enough support points. But 2nd option is good.
4	2a	5	You have to define smart clothes. It is great that they are smart but in which case exactly? If it senses your body temperature and heats you, then this is smart clothing. But if you skip the music with button on your

			sleeve, then this is not smart for me. I can do it with Arduino for you. It is only a remote controller clothing. For us, machine learning is smart. When you search "shoes" on Google, and you got sneakers advertisements in the corner of the website, then this is smart. They call everything smart nowadays. In short, under certain circumstances if it learns about you and take action from the learnt, then this is a smart product. This product is better than other kinds of smart clothes. If it is summer, I can't wear the long sleeve jacket and I can't use the smart sensors on its sleeve.
5	2b	5	If you can embed this screen on fabric, that screen must have a screen saver, cool-down screen. You can change the colour of screen-lock. Ring accessory is logical. They made this smart ring that only displays body temperature, for instance. It is nice to have these kinds of features with the additional items. But it is important to add a certain feature with these additional accessory items, not only for appearance. You designed this product for everyone not for a specific target group. There is a group of people who can pay only for appearance which is a few. Another group pays for functionality and the other pays only if it is cheap. "Paying for functionality" group is larger than others. So, if your ring looks aesthetic and has a simple functionality, your possibility of selling that product is higher.
6	3a	5	If it stimulates me via vibration, colour change or voice to force me to look at this screen, it is logical. There are smart watches that do same notifications which works fine. But here, the vibration or something else is important or else I can't pay attention to that notification.
7	3b	5	It helps. Apple made this after IOS 11 I guess. Every morning, it gives you information about weather. This means that people need to be informed about this. Yours gives information during the day which is also nice and better.
8	4	4	Personally, if I have this kind of notification that says that I caused the air pollution, it will bother me and I will turn this off. But just to be informed about monthly or weekly reminders, it is ok. If you want to make people aware and give negative feedback, you can use other people. You can give feedback about what other people around you done that month and cause air pollution. For sure, you have done the same, so that you can understand that it is not only their fault but yours also. It is informing indirectly. You can analyse any kinds of things in the future considering that lots of information will be on cloud.
9	5a	5	It is good to know your reward in advance. Just a simple go for a walk is not enough. But if it says you can burn the calories that you gain from the hamburger you ate last night, is great. If you enrich the notification content, it is great.
10	5b	3	If I make limitations, I would be interested. After some point, imagine that you are in the city centre and everywhere is filled with restaurants and markets and such, you get tired of this. Filtering is not the best solution but if it can solve this in a smarter way. It can make the filtration according to user's interest and gives you better and less information. This seems like open-ended. You need to revise this idea and work on that.
11	6a	4	In that case, there will be lots of advertisements. If it could be made, it would be great. But I don't believe it would be possible. No one can give you anything free of charge. If you offer free ticket to someone, that brand, company, community whatever would ask for advertisement. If it can be prevented, then why not? For example, when this Pokemon game released at that time, most people lost weight even though the aim was just to play the game. If the objective here is to promote people to walk or bike, and as a return give them small rewards, then yes, why not.
12	6b	4	It is related with the ones before so it is good. If you make reservations at once, it is effortless and easy which is great.
13	7	3	Since we are talking about future, we are not sure if smart phones will be in the same format. What we call "mobile phone" now is more powerful than what we called "computer" years ago. You can consider this as an alternative for mobile phone today, but future technology may provide you something that far beyond our imagination. If you have enough technology for this now, you can offer this as an alternative for sure. But future, we cannot be sure what mobile phones might offer us. This can be an interface, or display for a mobile phone. But a replacement of a phone, not sure. So, all power or capacity, elements are inside of the mobile phone, but this wearable can be a display like a screenshare. Because with today's technology, the batteries, and other components may need extra space in this glove so maybe defining a role that only as a screen reflector or controller might help. But also, the components' size may get smaller in the future so you won't need to worry.
14	8	5	This makes sense. You can also charge it by the motion energy of bicycle while biking. While you hold the handlebar of bicycle, you can charge it. You can make this by induction. If you have solar panels on back, you can have capillary cables (not real cables, print or fabric) inside sleeve. Inside your jacket's cuff, 1st bobbin. Ok, induced current works like this: current flow in a conductor produces magnetic field and if there is another conductor close to it but not touched, that current will be induced. You can charge anything like this but of course in the large scale, that magnetic field might be harmful for human. But the need of charging this wearable, cannot have an

			impact. So ok, if you wear this jacket with one conductor inside the cuff, and the other one inside the glove, then problem solved. Since they are close, glove can be charged, and communicate. Battery is a real trouble. Because the only batteries you can recharge in today's technology is Lithium-ion battery. And you have to be careful about pressure, heat and others. You can consider watch batteries shaped as a button or coin according to the feature of the wearable. If you keep the components that needs more battery, inside of the phone and use the glove as a screen or controller, you can consider. It may not last 5 years but could be 3 months which is still good. Of course, I am thinking in today's technology.
15	9	5	This is logical instead of downloading many different apps. Even today, they are trying to unite most of the things together. Smart phones are the best example for that. Bank cards, identity cards, driving license and others are becoming one simple card or system. This is the same and it must provide this system.
16	10	1	This may not work. For example, Mercedes-Benz brand cars have this feature. If there is a person in your blind spot, it turns a light on your rear window mirror. But not for every car, only inside the blind spot. It is not logical to warn you because the car is coming. Important part here is actually to understand the dangerousness of it and it can't understand it. If it can understand that the car is coming towards you or about to crush you, it is ok but I don't think it is possible. But it is possible to measure your possibility to crush with a bike. Because it knows your velocity, acceleration or road. But for the car behind you, it can only measure the seconds before it crushes. If also we are talking about smart cars, or autonomous cars, they will be smart enough not to make any accident. So, in that case, you wouldn't need this warning. You can consider a clothing as an alternative airbag. There are jackets that turns into an airbag when you are about to crush while driving a motorcycle. So, you don't need a helmet for that. You just wear it and it opens when need to protect you. It can also warn user in advance for the dangerous curves of the road. It might work.
			I don't think all the power and components should be in this glove, it should share some components with other devices. But in general, I liked the idea. You can consider to design a glove with 4 finger holes like a proper half glove, but palm area is cut out. Palm needs to be empty which is better for all day. And you can fold the screen on your hand. Foldable screens were existed even in 2016. But it takes time to be in the market. So, this product is possible but needs time. But battery problem needs to be solved efficiently because it is hard to think about future with today's conditions.

E9 *1986 – Textile Design, Smart Textiles – Fashion and Textile Design (PhD) – Assistant Professor*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	5	I think it might really work. You can design the closure part with different fitting options. Could be Velcro or press studs. So that you can produce one-fit glove but with 3 different closure options. Also, how much wide can be a wrist at most? I think you can solve this with one size. Do you think the material? It can be a sustainable fabric or accessories. It is beneficial that is portable. It is not hard to wear so you can't be too lazy to wear during the day. It is better than smart t-shirt or jacket because it is more practical so that it fits for purpose.
2	1b	2	Which material do you consider to use for this attachment? Is it up to you? Small magnets could be logical and I think you shouldn't use zipper. But still this attachment feature, I don't really find it necessary. If I take this off, I would prefer to put it in my bag or pocket. First of all, it is not aesthetical to attach something on you. Secondly, it is not functional to put it on your neckline, shoulder or other parts on your body. Maybe on sleeve to see the screen or on shoulder to hear or other vocal communications.
3	1c	4	I think the question is the feature of the product. What should we expect to see on the screen? So, it depends. Today we see that many people prefer to use these small screens of smart watches. Not only being notified but also read messages or make phone calls. So, I don't really think that small screen is a real issue. People are looking for more portable, easy usage products. But your small options seem a bit uncomfortable. It might limit the finger movement during the day. When I work or hold a pencil, I cannot use it. So, the wider screen options seem better and I would prefer that ones also. However, I am sure that there are people who can choose the small ones. Small ones might attract people instead of watch but I still think that they are not ergonomic. Maybe we don't get used it I don't know. If it fits on one finger without thumb, it might be more comfortable. But still, you have to work on ergonomic issues.

4	2a	4	I think being located in wrist area is better than other smart products if we consider fashion concern. Could be a bracelet also. Because clothes bring different fashion tastes. Smart jackets, tights and other products have already been produced but a few people preferred so far. But fabric is important here. Because it looks like an elastic bandage. You should think about a good quality fabric.
5	2b	5	Colour changing fabric is not that difficult. I produced one for my study. It changes colour related to weather conditions or if you heat intentionally. If you want a fabric to change colour, you heat it and after some time (depend on you), colour changes and goes back to original colour when temperature normalizes. Mine was only went to paler colour from the original one. But there are other materials that change colour with different options now. In the future, it will get better for sure. You can use thermochromic ink for some part of your patterns and the other part with pigment ink. So, you can provide pattern colour change due to temperature. We are talking about future, this colour changing materials exist now, so it will be enhanced in the future. You can even use shape-memory materials. You can weave or knit the fabric with this shape-memory alloys. You input a memory to the material that it will be in certain form in determined temperature degree. It changes into the defined shape from its normal state. For example, you can take this glove off and give a certain heat to make it smaller so that you can keep it in a small area, I don't know. Or depending on temperature again, you can grow a finger part and make it a full glove. We made it in curtains depending on sun heat. When sun rises and heat the curtain it shrinks and let the sun in, then gets longer after sunset when you need lights turned on. You should also think about a case to cover it. You can roll and put it inside. You can consider leather or other business type fabrics, or scuba-type fabrics for more sport look.
6	3a	5	Normally, I say these things to myself inside. This can definitely motivate.
7	3b	4	Very good. I don't usually check weather in the mornings before I go out. If this information is given without my intention to check weather, this will be beneficial. In that case, I can really consider to change my outfit which is better.
8	4	4	It would definitely make people aware. For example, I check my steps during the day. When I see those data, it doesn't demotivate me if numbers are low. I don't turn it off, either. I like to be informed. I think this is important. If you perform sustainable behaviour and be informed about it, you might be willing to continue. I don't think it is annoying if it will be more positive language and with cute emojis or icons. You may not directly blame people but just give information about pollution due to activities.
9	5a	4	I actually find it useful. I use this feature all the time and honestly, I looked for bike stations when I went to England. I couldn't find it because I didn't know the brand name. If every type of mobility is in the same app, it will be very useful. It can also give you a warning that a station is close to you.
10	5b	5	Especially when you go there as a tourist, this type of information is really important. Because you have no idea about the city. But also, it should be optional. I mean I should get this information when I want.
11	6a	5	This utterly satisfies.
12	6b	3	I feel like it may cause addiction. You will be just looking at screen instead of enjoying the day. It might be too much. If I get notifications all day, it might annoy me. But if it works by request, then ok.
13	7	4	Sometimes another issue is the security. Phones might be stolen. It is hard to find it from your bag, and you don't want to put it in your pocket, only option is to hold it. But this is also not the best. Better to be wrapped around your hand so that you prevent dropping. Does it cause discomfort while typing? When it's on your hand it is easy, but when you open it, I am not sure. You should think about a supportive material to make it stable. I don't think it is impossible to find this type of material in the future.
14	8	2	Can't you solve it in another way? People prefer different brands. In this case they can only choose your collection in this system which is limited. This could be disincentive. Maybe you can design a modular peace to attach any kinds of clothes from any brand. Could be hat or other accessories. Why doesn't it provide its own charge system without in need of other clothes? You can think about other types of energy instead of solar. You can put solar fibre on the glove or use bike's energy for charge. In the future, clothes could be designed to be fit in this system.
15	9	5	Great. It is a must. Also, in every city, these transport cards are different which is frustrating if you travel a lot.
16	10	4	I think this could be done in the theory. For example, in my car, the rear-window mirror has a light. And when there's a car in the blind spot it turns on and warns me. This type of features is beneficial but also you depend on the machine and get used to not paying attention. But this warning might be given when the biker needs to turn left or right, or needs to pass car road, or cross the streets but not all the time. This can distract you. Maybe it can only give you warning when you turn the handlebar of bicycle that you might lose your balance or something.
			I talked to one software company recently. They provided me a great amount of information about the

			automation systems, coding and materials for textile companies that I might consider as a future scenario. But they are already doing it. So many things you conceptualize, can be done mostly or fully. Especially, materials and ideas look satisfying and achievable. Only you should solve the elasticity and being firm at the same time when you make the screen bigger.

E10 — *1984 – Design Management, Start-up Ecosystem – Industrial Design (Ms) – Co-founder of Industrial Design Consultancy, Lecturer*

CO	CS	Satisfaction Scale	Expert Statement
1	1a	3	2 important questions here. Which kind of data are you interested in? How will you analyse it? Second question is later concern. First one is the main one. What is the data you want to collect? Then, you can decide the location of the product. Measurements that you can get from wrist area is too limited. What is data set that you want from here? From the city? User? User and city interaction? Do you want to know if user passes from a noisy area? Do you want to measure heart rate? Or do you want to see the relation of user's heart rate and carbon monoxide level of the city? Just to give example. I think you create an alternative to collect and display data you get from smart phones today.
2	1b	4	If this is not a solution for near future but a far future, then there is a problem. This looks like a function definition that can fulfil today's users' demands in city life with today's technology. If so, this is alright and even offers good solution. Where we are today in terms of data analytics, is unbelievable. Smart phones can estimate your height or footstep distance while it's swinging in your pocket or while you are holding it. Plus, it doesn't need human, it automatically makes measurements. Now we analyse these tiny little data and transform it into a big data. After 2000s, the hardware has almost lost its meaning. My job is to create physical products, another words hardware and it's no longer a real demand anymore. In today's world, hardware is a burden in technology world. Because hardware blocks iteration, distribution and manufacturing channels and costs more, demands more funding. Every physical presence demands other physical presence. You need technical people who tighten a screw, transport or carry it through your house. Virtual products changed this network need after communication revolution. The network from production to distribution became digital and the cost was reduced. Because of that, many companies or designers choose this way and hardware is a burden now. Dreaming about a hardware or designing it is a must of course. We are living creatures and of course we need something as a proxy. But this hardware must be thought as embedded to our body but not an external product around us. Your concept has a potential to be seen as a project in Kickstarter nowadays. Flexible screen might not be used as you propose but with embedded sensors in a stylish fabric is possible. I mean I feel this concept is so hardware oriented and belongs to today. This is not good or bad but just how I perceive this.
3	1c	4	It is only possible to evaluate if your options have particular context. Does it have any meaning if you locate this product on your finger? If you associate this product on my finger because of a UX function, then I can consider. I will give an example here. Tinder is one of the biggest companies in the world in terms of economic activity and user number. Dating app is not invented today. There were other apps before. But there is a reason. How they associate user with "Like" and "dislike" choices with finger gesture. This is basically the outcome of user experience and at the same time, this function made the app better than others. It is just the emotional bond while user make the choice, how you get involved. So, coming to your product, if this product enhances the user experience when it is located close to fingers, then of course it should be preferred. If it is located around the wrist only because of visibility under ergonomics or again around fingers only because of making it smaller, then this has no meaning. But as in the example I gave for dating apps and how one became different just because of a UX function, if your product offer this then these options become meaningful. You don't need to define the object as a glove with screen for the future. It can be anything beyond our knowledge. You should relate this to UX. If you don't then this is out of context. People are not rational to think about the comfort. Think about the clothes or accessories people choose to wear today. If we concern about the comfort of the product, if it causes swear or anything, we won't be consuming half of the products today. These are not only related with function. You should think about UX. This product can be a symbol for identity. This wearable can define that this person is this type of person. This may have a semantic meaning. But my daily comfort is not important here. If it is a consumer product, yes you are right. You have to think about function if I fly drone with this. If this is a daily product like mobile phone, product to maintain my daily life, the amount of area that covers my

			hand is irrelevant. You need to focus something else.
4	2a	4	This technology is not picky in terms of style. So yes, this is meaningful.
5	2b	4	It is better to look at past. Apple leaded the ecosystem creation. Just after Apple designed the phone; some other leaders in music, game and application fields were formed. This example is like designing switches or sockets. Imagine that you are producer of these products. Since they don't know this product is for which room that furnished with which furniture, which wallpaper colour, they prefer to make it invisible. The alternatives are very few like white or grey and compatible with any colour of furniture. Apple did the same. First, they didn't now user's age, style or relationship with technology; they prefer their product to be more invisible. Plus, they called it minimalism. So, the product must not be eliminated because of personal choices. After designing the real product, they (Apple) designed secondary accessories to personalize them which is strategical. To the past showed us that this is a logical strategy. Unisex look is similar to Apple's minimalist manner which is a proper strategy. The secondary accessory can have a meaning not only having an additional function or sensors, but also without sensor, just a simple aesthetic object that differentiate user from society.
6	3a	2	There are hundreds of products and applications that give these kinds of feedback. This idea has already consumed and old-fashioned. Ok, this can be done, but I am not sure about the affect on user. This might not be surprising. But of course, UX side is important here. Because as we spoke, to do something that was done before, still valuable depending on how you do it. What kind of difference or UX function you add is important. I have Apple watch that can estimate my movements and tells me "Stand up!" if I barely move that day. But this is not surprising anymore. But for instance, when I am at gym and using a machine, it tells me that I am doing this activity for a while, and asks if I want it to record it. How can you know that I am using that sport machine? Sensor is the same but interpretation is different. Today's generation's motivation is related with visibility. To make themselves visible. Not to be a person who is healthy or sportive but to be known as a healthy or sportive person. If we talk about Tiktok today, then we cannot speak about private life. These feedback might not even work today, so it must have a collective meaning. Your individuality is for being consumed by collective today.
7	3b	4	This is meaningful for a person who lives in Turkey. Riding a bicycle or motorcycle is not a common culture here, so I won't pay attention to weather when I dress before going out. But it is important. But this also might be too ordinary or not meaningful for the developed societies who use bicycles every day.
8	4	5	This data can have a collective meaning. It has a potential to make myself more consumable. Based on this information, user might be more acceptable in society. If we see this from the perspective of political correctness, this is important.
9	5a	2	If you present a more defined gamification concept, then the evaluation might change. But this is a bit vague. I can have this information from anywhere so the presentation style might change, or it can add a meaning to my presence in society.
10	5b	3	This feature is better for tourists. We mostly depend on user comment when we consider to buy a simple product now. It is old but still valid.
11	6a	4	Having more followers in Instagram is also an example of gamification. So, this is also valid. The reward in this example is visibility and even privilege. If they have any kind of return from their actions no matter if it is a free ticket or not, this will be effective. What might be the reward and the motivation is a UX topic.
12	6b	5	Frequency of consumption and personal interest is important here. You Tube is a platform that doesn't have an entrance barrier so you can find everything. Still, there is another platform called Spotify. Because Spotify's algorithm is better in terms of finding your music interest and introduce similar or other interesting types for you. Here, it is important to make meaningful suggestions for you. It is also better for the product to be beneficial for sustainable economy. Here, it can suggest a lately opened place. User can feel the privilege to discover that place first, and the business can be successful easily.
13	7	3	Screen is a little bit detail for your concept. Screen is something that we owe in different forms like phones, TVs, PCs, projections today. I think integrating a screen on hand or palm here is not an incredible improvement or progress. I don't find it necessary. I made R&Ds and all the effort to have a screen on my hand. I should have something better in the end. Even Google Glass didn't work out. That product was external. Yours is the same. It has to be invisible on the body. Yours is also not invisible enough. Now, they are working on Neuralink. Elon Musk's project. So, what I am trying to say is, we should get more benefit than just a screen if this is product embedded on our body.
14	8	3	Could be. It doesn't make any difference to find solution for the energy with sun or an unknown particle.

			This is a requirement and, in the future, this will be solved. Just like developing vaccine in an impossible duration in pandemic. We need to overcome this. So, evaluating this might not be meaningful because this might be already solved.
15	9	4	Finance technologies are already doing it by uniting all bank accounts or credit cards. It is hard to do in practice now, but still valuable and important. You have to download the app to become a consumer for that scooter brand. And it is an obstacle for that company. If you avoid starting condition, this is meaningful. Also, it is hard to define how to do this. but the projection is right.
16	10	4	Your clothes have a potential that your TV may not give to you. I how can TV make you frightened if it doesn't touch you? But something on your body can. Feedback can be given in different and more effective forms. In this example, you try this so it is meaningful. This feedback might be more effective than any others since you feel it on your body. Skin has a real potential. It has the widest surface area. You can heat, cold, vibrate or more. But you should not think about vibrating as a feedback because you see phones are vibrating today.
			Our consumption habits are more intangible rather than functional. A product should not necessarily interact user with a screen. It can be anything. This might be a limitation for you. Do you know why I use smart watch? You set an alarm and your phone rings in the morning, right? This might be personal but I am sensitive to voices and when the phone rings it panics me when I wake up. This watch only vibrates as an alarm and I can wake up peacefully. This is very simple. But it is important for me. If I invest something for the future, I would go for a product that is more embedded on human body. And the people who are afraid of technology would definitely change in 30 years.

M. Distribution of Satisfaction Levels of Experts

	Concept solution topics		*Highly dissatisfied*	*Dissatisfied*	*Neutral*	*Satisfied*	*Highly satisfied*	*Total*
1	A. half-glove	F	0	0	3	4	3	10
		%	0,0	0,0	30,0	40,0	30,0	100,0
	B. modularity	F	0	5	1	2	2	10
		%	0,0	50,0	10,0	20,0	20,0	100,0
	C. unisex/flexible	F	0	0	2	5	3	10
		%	0,0	0,0	20,0	50,0	30,0	100,0
2	A. system design	F	0	0	1	4	5	10
		%	0,0	0,0	10,0	40,0	50,0	100,0
	B. customization	F	0	0	0	4	6	10
		%	0,0	0,0	0,0	40,0	60,0	100,0
3	A. extra feedback	F	0	1	1	0	8	10
		%	0,0	10,0	10,0	0,0	80,0	100,0
	B. garment need	F	0	0	0	4	6	10
		%	0,0	0,0	0,0	40,0	60,0	100,0
4	A. unsustainable	F	0	1	0	5	4	10
	action	%	0,0	10,0	0,0	50,0	40,0	100,0
5	A. tracker	F	0	1	1	1	7	10
		%	0,0	10,0	10,0	10,0	70,0	100,0
	B. city database	F	0	1	2	2	5	10
		%	0,0	10,0	20,0	20,0	50,0	100,0
6	A. game/award	F	0	0	0	3	7	10
		%	0,0	0,0	0,0	30,0	70,0	100,0
	B. game/walk	F	**1**	0	2	4	3	10
		%	**10,0**	0,0	20,0	40,0	30,0	100,0
7	A. phone features	F	0	0	2	5	3	10
		%	0,0	0,0	20,0	50,0	30,0	100,0
8	A. solar garments	F	**1**	1	3	1	4	10
		%	**10,0**	10,0	30,0	10,0	40,0	100,0
9	A. wireless interact	F	0	0	0	2	8	10
		%	0,0	0,0	0,0	20,0	80,0	100,0
10	A. vibration alert	F	**1**	2	2	4	1	10
		%	**10,0**	20,0	20,0	40,0	10,0	100,0
	F: Frequency %: Percentage							

N. User Experience Questionnaire Form

English Version of the Questionnaire:

Design of Fashionable Wearables to Promote Sustainable Behaviours in the Context of Smart Cities - User Experience Questionnaire

This user experience questionnaire is for a research carried out in the process of doctoral degree on the studies of Design, in the environment of IADE-Universidade Europeia, Lisbon.

By participating in this survey, you will help us to have the comprehensive assessment of user experience.

Türkçe için lütfen linke tıklayın:
https://forms.gle/8aW3nRASbEwL6y5k7

We have 2 short videos for you to watch.

First video (3 min) is related with personas' some of daily problems. Here, you will be introduced our personas who live in their future smart city.

Please indicate the extent to which you share same problems as our personas. *

	1	2	3	4	5	6	7	
I have none of these problems	○	○	○	○	○	○	○	I have all the problems

Which mobility mode do you mostly use in your everyday life? (You can select more than one.) *

- [ ] public transport (bus, metro, tram,...)
- [ ] on-demand transport (uber, mytaxi,...)
- [ ] private car
- [ ] taxi
- [ ] bike or bike-share
- [ ] walk
- [ ] Diğer: _____

User Experience Questionnaire

In an attempt to change the situation that was presented in the previous video, we developed a concept of a technology-based product. So, we ask you to watch this new video and fill in the questionnaire.

The quiz consists of a set of pairs of opposing attributes, which can be applied to the proposed concept. The circles between the attributes represent a gradation between the opposites. Choose the position which best represents your opinion on the proposed concept.

Please answer spontaneously. Do not overthink your answer in order to convey your most spontaneous impression. What counts is your personal opinion and please remember: there is no wrong or right answer!

Second video (2,5 min) is related with the conceptual design solution that we come up with. Here, you will also see our prototype.

Please tick the circle that most closely reflects your impression about the conceptual design. We want you to think about the whole service attached in the system. Please do not only judge the product (glove).

Example:

attractive	○	⊗	○	○	○	○	○ unattractive

This response would mean that you rate the application as more attractive than unattractive.

1. *

	1	2	3	4	5	6	7	
annoying	○	○	○	○	○	○	○	enjoyable

2 *

	1	2	3	4	5	6	7	
not understandable	○	○	○	○	○	○	○	understandable

3 *

	1	2	3	4	5	6	7	
creative	○	○	○	○	○	○	○	dull

4 *

	1	2	3	4	5	6	7	
easy to learn	○	○	○	○	○	○	○	difficult to learn

5 *

	1	2	3	4	5	6	7	
valuable	○	○	○	○	○	○	○	inferior

6 *

	1	2	3	4	5	6	7	
boring	○	○	○	○	○	○	○	exciting

7 *

	1	2	3	4	5	6	7	
not interesting	○	○	○	○	○	○	○	interesting

8 *

	1	2	3	4	5	6	7	
unpredictable	○	○	○	○	○	○	○	predictable

9 *

	1	2	3	4	5	6	7	
fast	○	○	○	○	○	○	○	slow

10 *

	1	2	3	4	5	6	7	
inventive	○	○	○	○	○	○	○	conventional

11 *

	1	2	3	4	5	6	7	
obstructive	○	○	○	○	○	○	○	supportive

12 *

	1	2	3	4	5	6	7	
good	○	○	○	○	○	○	○	bad

13 *

	1	2	3	4	5	6	7	
complicated	○	○	○	○	○	○	○	easy

14 *

	1	2	3	4	5	6	7	
unlikable	○	○	○	○	○	○	○	pleasing

15 *

	1	2	3	4	5	6	7	
usual	○	○	○	○	○	○	○	leading edge

16 *

	1	2	3	4	5	6	7	
unpleasant	○	○	○	○	○	○	○	pleasant

17 *

	1	2	3	4	5	6	7	
secure	○	○	○	○	○	○	○	not secure

18 *

	1	2	3	4	5	6	7	
motivating	○	○	○	○	○	○	○	demotivating

19 *

	1	2	3	4	5	6	7	
meets expectations	○	○	○	○	○	○	○	does not meet expectations

20 *

	1	2	3	4	5	6	7	
inefficient	○	○	○	○	○	○	○	efficient

21 *

	1	2	3	4	5	6	7	
clear	○	○	○	○	○	○	○	confusing

22 *

	1	2	3	4	5	6	7	
impractical	○	○	○	○	○	○	○	practical

23 *

	1	2	3	4	5	6	7	
organized	○	○	○	○	○	○	○	cluttered

24 *

	1	2	3	4	5	6	7	
attractive	○	○	○	○	○	○	○	unattractive

25 *

	1	2	3	4	5	6	7	
friendly	○	○	○	○	○	○	○	unfriendly

26 *

	1	2	3	4	5	6	7	
conservative	○	○	○	○	○	○	○	innovative

Finally, some facts about you.

Please fill all the areas below.

Year of birth *

Yanıtınız

Which city do you live in? *

Yanıtınız

Gender *

- ○ Female
- ○ Male

Education completed *

- ◯ Less than high school
- ◯ High school
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ PhD

Civil Status *

- ◯ Married or cohabiting with another person
- ◯ Single

Professional Status *

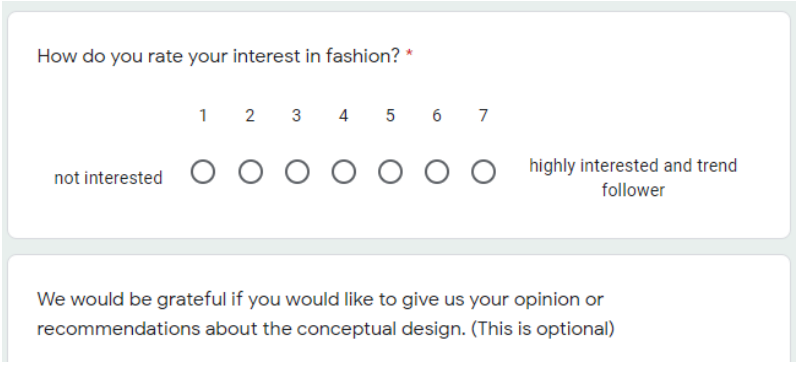
- ◯ Student
- ◯ Employed
- ◯ Unemployed
- ◯ Self-employed
- ◯ Diğer: _____

Do you have children? *

- ◯ Yes
- ◯ No

Do you have any experience with a wearable such as smart watch, smart bracelet or other? *

- ◯ Yes, I've tried one and I am considering to purchase.
- ◯ Yes, I've purchased one and I like it.
- ◯ Yes, I've purchased one but I lost my interest.
- ◯ No, I have no experience but I am curious.
- ◯ No, I have no experience and I am not interested.
- ◯ Diğer: _____



Turkish Version of the Questionnaire (First page)

O. Distribution of UEQ Answers per Item

Nr	Item	1	2	3	4	5	6	7	Scale
1	annoying/enjoyable	1	3	5	25	34	35	33	Attractiveness
2	not understandable/understandable	1	0	7	16	26	37	49	Perspicuity
3	dull/creative	8	10	18	16	18	29	37	Novelty
4	difficult to learn/easy to learn	3	6	10	17	21	34	45	Perspicuity
5	inferior/valuable	0	5	9	24	29	28	41	Stimulation
6	boring/exciting	0	7	10	24	26	34	35	Stimulation
7	not interesting/interesting	3	8	7	21	21	30	46	Stimulation
8	unpredictable/predictable	4	9	13	43	34	19	14	Dependability
9	slow/fast	0	0	4	42	29	32	29	Efficiency
10	conventional/inventive	3	5	6	23	38	29	32	Novelty
11	obstructive/supportive	0	1	6	17	31	39	42	Dependability
12	bad/good	1	1	5	24	28	32	45	Attractiveness
13	complicated/easy	1	5	7	31	34	30	28	Perspicuity
14	unlikable/pleasing	0	1	9	33	36	29	28	Attractiveness
15	usual/leading edge	4	5	14	30	39	25	19	Novelty
16	unpleasant/pleasant	0	0	9	33	28	40	26	Attractiveness
17	not secure/secure	1	7	9	34	30	32	23	Dependability
18	demotivating/motivating	1	6	5	30	37	24	33	Stimulation
19	does not meet expectations/meets expectations	1	5	6	30	40	34	20	Dependability
20	inefficient/efficient	0	3	8	24	43	32	26	Efficiency
21	confusing/clear	1	2	5	20	36	37	35	Perspicuity
22	impractical/practical	0	4	7	23	27	38	37	Efficiency
23	cluttered/organized	0	1	8	21	35	36	35	Efficiency
24	unattractive/attractive	1	4	17	26	31	30	27	Attractiveness
25	unfriendly/friendly	2	2	10	36	27	26	33	Attractiveness
26	conservative/innovative	2	0	3	15	29	43	44	Novelty

P. Qualitative Analysis of User Experience Feedback

Neutral evaluation (N:10)	I couldn't find the relation between the fabric and internet connection/the screen. Is it 3D technology or just an image? A bit confusing and not clear. But the idea is good. If it is just for bike and walk promotion, it is too technological. Good luck! (U7) I use Apple Watch and this design reminds me of it. It doesn't seem new for me. The idea is good but I am not sure about the benefits comparing to other smart watches. (U8) First, it is a very practical accessory. However, it evokes me masks because of the current conditions and this perception of mask cause a negative impact on me. Second, it was really a good idea to present the concept via videos. It was highly clear, good work! (U30) I can't quite understand the difference between smart watches. All these features could be a single application that you can download to smart watches. I think the missing product is not a wearable but just a holistic application for biking or walking. Charging and battery issues would remain the same. Still, it is an interesting technology. (U31) If it look more modern instead of bandage-looking, users might be more pleased.(U46) The idea of designing a wearable is highly creative but I have doubts about glove. We use our hands quite often and gloves that we use in necessary cases (in cold, during sport,...) restrict most of our movement and become an extra part of our body. For short durations might be possible, but it could be tricky for long durations. It can be clearly explained if this wearable would be used for every hour of the day or just in some certain hours (e.g. when we are not home). (U92) Could be better if it has more modern style rather than bandage-looking. Users might like it more. (U101) I know that it seems to have a mobility similar that a glove has, but I kept thinking about the screen folding when I move my hand. Also, it is too big. (U106) Would be cool, but looks very very unrealistic. Would be a technical wonder and super expensive. (U111) From what I understood you want to create a wearable phone, and basically the example with the bikes can be made with an app on the phone. I get the concept, and it can be more practical than the phone in a sense, but I don't know if people would like to be wearing it all the time, it would not be practical to use during work for some people, and it occupies the full hand except the fingers, it might be hot too. I think the concept is innovative and creative, I just think it does what other stuff can do. (U114)
Negative evaluation (N:5)	It looks like an alternative of current wearable designs. It is still in progress and conceptual, but I wouldn't prefer to wear it as a glove. (U10) It is not very clear about the relation of the problem definition and the solution. I don't understand why and how this product can encourage me to walk or bike. Besides, this product may cause attention problem and could be dangerous during these activities. (U19) There is already a huge market for smart watch technology that is compatible with phones and earphones. In this case, I don't find this bracelet beneficial and useful. It might be more efficient solution to enhance the smart watch apps and increase the usage. Besides, it is not stylish instead it is boring. I won't prefer to use it every day and it is not even close to the elegancy and ergonomics of metal chain smart watches. (U59) The project is just like smart watch or smart phone. I couldn't understand the novelty of it. (U98) I keep using my bikes as my MAIN means of transportation. I consciously choose public transportation for destinations outside town. I occasionally look for a car ride. I don’t care for gadgets like cyber watches etc. Is this survey about promoting a commercial product? (U134)

Positive evaluation (N:21)	Extremely successful. With the help of technology, the product can be widely used by people. (U1) I loved it. (U3) Smart clothes that gain power from motion energy would be great. (U15) I think the screen surface should be plainer. Glove can get wet and might not be practical for screen when we close our hands. But the idea is really supportive and promoter. Congrats! (U16) I only have doubts about the car warning system. I believe that it may not be compatible with all cars and may not be integrated with the whole system. So that it could be inefficient. Apart from that, I think the product is creative. Well done. (U17) First things come to my mind: How could be a screen on the fabric? Is it going to be a touchable screen? How it won't be deformed? Still, it is very creative and successful. (U29) It could be more attractive if the product occupied less space on skin for the summer. (U34) It is interesting but it would be great to know more about usability details. For example, which textile materials might be used, how can a product like an alternative for smart phone, make thin and implement on a glove, or others. (U38) It might be more interesting that it could only occupy upper hand and palm instead of whole wrist. For ventilation and avoid sweating, net fabrics might be used for the parts that have no electronics. It might also be developed from heat sensitive fabric dye for colour change. So, more improved version of this wearable can be made. (U45) It was highly beneficial for me to use smart watch. This is a creative idea and could be a much better option than smart watch so I am curious. (U50) It is a really successful project and it has a potential to be improved and be so much better. I wish you a continued success. (U63) Great!(U69) There can be S-M-L options. The digital part of the system should be modular so that you can take it out. Fabric should be washable. (U80) Very successful. (U94) I really liked it, good idea and I would like to wear it.(U95) It is innovative and useful design. (U96) I like the design and the idea in term of fashion. But I think the point of saying “you don’t need an app” it’s actually not true. The only way for this would be to have an agreement with each city that we are interested in, but that defeats the purpose in my view because it would only be useful in the cities that join the agreement, which is the problem with all the e-sharing platforms right, otherwise we would only need one app for all the cities in the world. Also in this sense, I think the device can be seen as another smartphone, only in a half glove form (which I think is pretty cool though). I think you are on the right track but need to re think the things I’ve mentioned above a bit. I hope you find these comments useful, keep it up! (U102) You should think of options for hotter days, when the glove can be uncomfortable on the hand. Nice idea! (U105) It could beneficial for the security of the product to add the fingerprint unlocking option. (U108) Good idea. (U127) Good conceptual idea. Let's see how it works and how much it costs. (U128)
Suggestions	Smart clothes that gain power from motion energy would be great. (U15) I think the screen surface should be more plain. Glove can get wet and might not be practical for screen when we close our hands. But the idea is really supportive and promoter. Congrats! (U16) I can't quite understand the difference between smart watches. All these features could be a single

application that you can download to smart watches. I think the missing product is not a wearable but just a holistic application for biking or walking. Charging and battery issues would remain the same. Still, it is an interesting technology. (U31)

It could be more attractive if the product occupied less space on skin for the summer. (U34)

It might be more interesting that it could only occupy upper hand and palm instead of whole wrist. For ventilation and avoid sweating, net fabrics might be used for the parts that have no electronics. It might also be developed from heat sensitive fabric dye for colour change. So, more improved version of this wearable can be made. (U45)

If it looks more modern instead of bandage-looking, users might be more pleased. (U46)

There is already a huge market for smart watch technology that is compatible with phones and earphones. In this case, I don't find this bracelet beneficial and useful. It might be more efficient solution to enhance the smart watch apps and increase the usage. Besides, it is not stylish instead it is boring. I won't prefer to use it everyday and it is not even close to the elegancy and ergonomy of metal chain smart watches. (U59)

There can be S-M-L options. The digital part of the system should be modular so that you can take it out. Fabric should be washable. (U80)

The idea of designing a wearable is highly creative but I have doubts about glove. We use our hands quite often and gloves that we use in necessary cases (in cold, during sport,...) restrict most of our movement and become an extra part of our body. For short durations might be possible, but it could be tricky for long durations. It can be clearly explained if this wearable would be used for every hour of the day or just in some certain hours (e.g. when we are not home).

Could be better if it has more modern style rather than bandage-looking. Users might like it more. (U101)

You should think of options for hotter days, when the glove can be uncomfortable on the hand. Nice idea! (U105)

It could beneficial for the security of the product to add the fingerprint unlocking option. (U108)

Opinions

Extremely successful. With the help of technology, the product can be widely used by people. (U1)

I loved it. (U3)

I couldn't find the relation between the fabric and internet connection/the screen. Is it 3D technology or just an image? A bit confusing and not clear. But the idea is good. If it is just for bike and walk promotion, it is too technological. Good luck! (U7)

I use Apple Watch and this design reminds me of it. It doesn't seem new for me. The idea is good but I am not sure about the benefits comparing to other smart watches. (U8)

It looks like an alternative of current wearable designs. It is still in progress and conceptual, but I wouldn't prefer to wear it as a glove. (U10)

I only have doubts about the car warning system. I believe that it may not be compatible with all cars and may not be integrated with the whole system. So that it could be inefficient. Apart from that, I think the product is creative. Well done. (U17)

It is not very clear the relation of problem definition and the solution. I don't understand why and how this product can encourage me to walk or bike. Besides, this product may cause attention problem and could be dangerious during these activities. (U19)

First things come to my mind: How could be a screen on the fabric? Is it going to be a touchable screen? How it won't be deformed? Still it is very creative and successful. (U29)

First, it is a very practical accessory. However, it evokes me masks because of the current conditions and this perception of mask cause a negative impact on me. Second, it was really a good idea to present the concept via videos. It was highly clear, good work! (U30)

I can't quite understand the difference between smart watches. All these features could be a single application that you can download to smart watches. I think the missing product is not a wearable but just a holistic application for biking or walking. Charging and battery issues would remain the same. Still, it is an interesting technology. (U31)

It is interesting but it would be great to know more about usability details. For example, which textile materials might be used, how can a product like an alternative for smart phone, make thin and implement on a glove, or others. (U38)

It was highly beneficial for me to use smart watch. This is a creative idea and could be a much better option than smart watch so I am curious. (U50)

There is already a huge market for smart watch technology that is compatible with phones and earphones. In this case, I don't find this bracelet beneficial and useful. It might be more efficient solution to enhance the smart watch apps and increase the usage. Besides, it is not stylish instead it is boring. I won't prefer to use it every day and it is not even close to the elegancy and ergonomy of metal chain smart watches. (U59)

It is a really successful project and it has a potential to be improved and be so much better. I wish you a continued success. (U63)

Great!(U69)

The idea of designing a wearable is highly creative but I have doubts about glove. We use our hands quite often and gloves that we use in necessary cases (in cold, during sport,...) restrict most of our movement and become an extra part of our body. For short durations might be possible, but it could be tricky for long durations. It can be clearly explained if this wearable would be used for every hour of the day or just in some certain hours (e.g. when we are not home).

Very successful. (U94)

I really liked it, good idea and I would like to wear it. (U95)

It is innovative and useful design. (U96)

The project is just like smart watch or smart phone. I couldn't understand the novelty of it. (U98)

I like the design and the idea in term of fashion. But I think the point of saying “you don’t need an app” it’s actually not true. The only way for this would be to have an agreement with each city that we are interested in, but that defeats the purpose in my view because it would only be useful in the cities that join the agreement, which is the problem with all the e-sharing platforms right, otherwise we would only need one app for all the cities in the world. Also in this sense, I think the device can be seen as another smartphone, only in a half glove form (which I think is pretty cool though). I think you are on the right track but need to re think the things I’ve mentioned above a bit. I hope you find these comments useful, keep it up! (U102)

I know that it seems to have a mobility similar that a glove has, but I kept thinking about the screen folding when I move my hand. Also it is too big. (U106)

Would be cool, but looks very very unrealistic. Would be a technical wonder and super expensive. (U111)

From what I understood you want to create a wearable phone, and basically the example with the bikes can be made with an app on the phone. I get the concept, and it can be more practical than the phone in a sense, but I don't know if people would like to be wearing it all the time, it would not be practical to use during work for some people, and it occupies the full hand except the fingers, it might be hot too. I think the concept is innovative and creative, I just think it does what other stuff can do. (U114)

Good idea.(U127)

Good conceptual idea. Let's see how it works and how much it costs. (U128)

I keep using my bikes as my MAIN means of transportation. I consciously choose public transportation for destinations outside town. I occasionally look for a car ride. I don’t care for gadgets like cyber watches etc. Is this survey about promoting a commercial product? (U134)

Q. Conference Paper: Promoting Sustainable Behaviour Through Fashionable Technology

Promoting Sustainable Behaviour Through Fashionable Technology

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ABSTRACT

There is an urgent need for global action and mission settlement that shape the future towards a strong contribution to sustainability, which is one of the greatest challenge that our society faces. The understanding what underlines the adoption of sustainable behaviours shall be an important improvement since can provide the opportunity to design more effective solutions. Furthermore, the current trends show an increasing dependence of our societies on digital technologies (e.g.,wearables, worldwide network connectivity, the so-called Internet of Things), in many of basic activities (e.g.,communication, socialization, learning, consumption) (The Innovation Group, 2018). Besides that, new technology-based possibilities are being suggested to solve many societal problems such as energy and waste reduction, water treatment, protection of natural systems (Mulder, Ferrer, & Van Lente, 2011). Some examples of these technology-based solutions can already be found successful in the promotion of safety, health and wellbeing, military, and entertainment (Hanuska, et al., 2016) but remain relatively unexplored in what regards sustainability. Also, very well established is the power of pleasurable and attractive objects on the users, satisfying their need for identity (one of the fundamental non-material human needs) with fashion (Fletcher, 2008, p. 121; Max-Neef, 1992). These pleasurable, fashionable objects are able to seduce the users towards a behavioural change since they cause enjoyment and satisfaction, which influences intrinsic motivation (Ryan & Deci, 2000). In this sense, Fashionable Technology, which refers to a topic that is "an intersection of design, fashion, science, and technology" (Seymour, 2009), can be seen as a potential way to motivate urban users to adopt sustainable behaviours. In this context, this doctoral research aims to explore the extent that Fashionable Technology (smart fashion product) can promote sustainable behaviours in urban contexts. To achieve the proposed objective, a mixed methodology will be used, and user-centred design approach will be followed. This article presents a theoretical background for this research and an outline of the methodology to be used.

Keywords: Fashionable Technology, Sustainable Behaviour, Internet of Things, User-Centred Research

INTRODUCTION

Sustainability is one of the greatest key challenges that our society faces, raising a number of global problems that threaten our future such as pollution, climate change, depletion of resources, ecological devastation, global inequity (The World Commission on Environment and Development, 1987; Mulder, Ferrer, & Van Lente, 2011; Mazzucato, 2018). The term sustainable development, as coined by the Brundtland Commission in 1987, defines as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987). Sustainability is represented as an end point of sustainable development, in a sense that a holistic approach of sustainable development is required to achieve sustainability (Sartori, Latronico, & Campos, 2014; Prugh & Assadourian, 2003). European Union (2011), in Horizon 2020, has identified important societal challenges, requiring urgent attention, which include several topics related with sustainability. Although the challenge is

not new, recent reports suggest the adoption of mission-based approaches in an attempt to raise awareness about societal challenges (Mazzucato, 2018; European Union, 2011; ALLEA, HERA, ELI, ESA, EuroScience, GYA, Net4Society, 2017).

The promotion of sustainable habits, having the people as a starting point for the change, has been suggested as one of the main key to achieve sustainable development (Bhamra, Lilley, & Tang, 2011; Lilley, 2009; Sustainable Consumption Roundtable, 2006). For many products, the use phase, where people interact with artefacts, contributes most of the total environmental impacts and often determined by user behaviour (Lidman & Renström, 2011). Despite being concerned with sustainability, people are often engaged in unsustainable behaviours or, at least resist to adopt others that are being suggested, stressing the need for motivation and empowerment of sustainable actions (Manning, 2009). In this sense, understanding what underlines a sustainable behaviour and behavioural change for sustainability, would be an important contribution for shaping sustainable future.

Fashion, on the other hand, which is a formation of desire for pleasure, new experiences, status and identity (Fletcher, 2008), is an important satisfier for individuals. Fashion products are met with the desires and emotional needs of users which are complex, subtle and inexhaustible (Fletcher, 2008). In this sense, fashion products will be a considerable motivation tool for behavioural change considering sustainability. Even though several contributions to sustainable fashion context are existed with significant approaches and strategies (Fletcher, 2008; Niinimaki, 2013; Hethorn & Ulasewicz, 2015; Gwilt, 2012), fashion industry is currently one of the most disruptive industry (Eder-Hansen, et al., 2017; Loetscher, 2017). According to recent statistics, fashion industry produces 2.1 billion tons of waste such as disposed clothing/cut-offs each year, global consumption of clothes also doubled between 2000 and 2014. Besides that, this industry emits tons of CO_2, increases local water impacts, uses a lot of toxic chemicals which demonstrates that fashion is far from sustainable (Loetscher, 2017). The improvements for sustainable fashion are generally found in design process, production, distribution, utilization and end-of-life phases of fashion products. Regarding all related contributions and recent statistics, the need of alternative ideas in the field such as focusing on promoting sustainable behaviour is an important starting point of this study.

In the current society, while sustainability is a significant challenge that endanger future, technology is deeply entrenched in daily lives as well. Besides, UN General Assembly (2015) suggests in the 2030 General Agenda for Sustainable Development, strengthening access to science, technology and innovation, enhancing knowledge sharing and the use of enabling technology in particular information and communications technology. Several future reports build forecasts related with technology and innovation, smart computing and worldwide network connectivity regarding the growing tendency of smart objects and society (The Innovation Group, 2018; Verizon, 2016). Considering determined areas and relation between each other, this research is framed in promoting sustainable behaviour in the scope of Fashionable Technology intersection with incorporation of Internet of Things network. Throughout this paper, a doctoral design research proposal will be explained and discussed as well as how it is expected to contribute to this universal problem.

THEORETICAL BACKGROUND

Sustainable Behaviour

Changing user behaviour through product, service or system design is a growing research field of concern. Behavioural design studies to design strategies, develop models to influence sustainable user behaviour and promote sustainable usage, have expanded the field rapidly (e.g. (Lilley, 2009; Wever, Van Kujik, & Boks, 2008; Tang, 2010; Lockton, Harrison, & Stanton, 2010; Lidman & Renström, 2011). Strategies in the roof of "Designing for Sustainable Behaviour", mainly influenced and enhanced from the behaviour and behavioural change models (Spencer, 2014). In this case, understanding behaviour and influencers of behavioural change is important. There are numerous theories about physiological and psychological needs, values, attitudes, incentives and habits can all be used to define or change human behaviour (Lidman & Renström, 2011).

Various factors need to contribute to an individual behaving in a particular manner. People do not always behave reasonably or logically and are often affected by number of cognitive, social and memory biases (Filippou, 2017). Manning (2009) claims that most people want to live in a way that treats ecosystems we depend on with care and respect, even though they found themselves in unsustainable daily behaviours that have negative environmental impacts. One reason is people's rational minds may know that change is needed, however it is not always the rational minds that drive the behaviour. People think in two different cognitive systems of reasoning: A rule-based which is reflective, conscious, self-aware, and an associative system which is automatic, unconscious, sensory-driven (Sloman, 1996; Thaler & Sunstein, 2008). Manning (2009) addresses the problem of sustainable behaviour as having little appeal to the associative system:

> *Consider a behavior like biking to work: a person's rule-based system thinks it's a great idea because of all the benefits (health, money savings, fitness), but his associative system responds with a definitive "No way!" perhaps because it just can't handle the idea of walking into the office with "helmet hair." One way to empower sustainability is to make sustainable actions appealing to the associative system (…) A second strategy is to get the attention of the rule-based system so that it can assert itself against the associative system's rejection of a sustainable action ("Helmet hair is really no big deal. We're biking!") (Manning, 2009, p. 3).*

There are other several strategies and considerations to empower sustainable behaviour. One of the recent project that was funded by European Union, outlines 12 strategies that can be used to promote sustainable behaviours in people's everyday life including both what is commonly called "Nudge" (Thaler & Sunstein, 2008) and "Think" (John, et al., 2013) behavioural approaches (Petersson, 2016). Using social norms, attracting attention, giving feedback, gaining commitments, triggering reciprocity, engaging values, connecting to nature are some of the examples of these strategies. Similar strategies are outlined in order to influence and encourage sustainable behaviour as they are enhanced versions of behavioural change models. Mainly, two aspects are seen to change behaviour: motivation and ability. One model that is called Fogg Behavioural Model (FBM) improves the understanding of this process by mapping the relationship between motivation and ability and at what point behavioural triggers can be effective for persuasive design. "The model asserts that for a target behaviour to happen, a person must have sufficient motivation, sufficient ability (simplicity), and an effective trigger" (Fogg, 2009).

Fashionable Technology

Fashionable technology term was first used in 2000, meaning "the intersection of design, fashion, science, and technology" (Seymour, 2009) that contains fashionable wearables and embedded technologies. Seymour (2009) defines fashionable wearables as "designed" garments, accessories, or jewelry that combine aesthetics and style with functional technology. Embedded technologies influence the wearability, comfort and aesthetic of a fashionable wearable. The incorporation of technology depends on the context of use and the desired interaction between the fashionable wearable and its surrounding environment.

The other relative term which is wearable technology, on the other hand, refers to different forms of electronic devices that can be directly worn on the body, including smart watches, body sensors, smart clothing, etc (Perry, Malinin, Sanders, Li, & Leigh, 2017; Hanuska, et al., 2016). Smart clothing in this relation is defined as a new garment feature which can provide interactive reactions by sensing signals, processing information, actuating the responses (Matilla, 2006). Similar terminology such as interactive clothing, intelligent clothing, smart garment, and smart apparel is used interchangeably representing for this type of clothing. In this sense, wearable technology term refers particularly to computer technologies and electrical engineering (Seymour, 2009) rather than the aesthetics and style dimensions of fashion design. This study will adopt Seymour´s terminology and use "fashionable technology" term as a roof of referring to all. Additionally, "smart fashion product" will be used indicating "fashionable wearables" to encompass all type of fashion products (e.g. garment, accessory, jewellery, …) and emphasize the data generating, interactive feature.

The tendency of getting smarter and fashionable technology suggests that fashion products are been increasingly seen as an interface for technology. The momentum of fashionable technology especially after 2000s (Syduzzaman, Patwary, Farhana, & Ahmed, 2015) and leading fashionable wearable markets (Hanuska, et al., 2017) ensure the future of fashion industry. Companies beneath fashionable technology market gravitates to four primary marketplaces: Infotainment, fitness and wellness, military and industrial, healthcare and medical. Real time data transmissions, monitoring activity, emotions, signs, sense augmentation and so forth technologies are used under these markets (Hanuska, et al., 2017).

Seymour (2009), identifies several design considerations in order to construct a fashionable wearable. These considerations are included in seven factors which are body ergonomics/wearability, perception, functionality, technology, materials, energy and recycle. Moreover, ubiquitous computing, wireless communication and sensor technology terms are specifically indicated as design considerations in technological factor of construction of fashionable wearables. Beginning with the focus of computing power being embedded everywhere, the term "ubiquitous computing" coined by Mark Weiser, evolved into Internet of Things (IoT) with network connectivity (McEwen & Cassimally, 2014). When this digital enablement of all products specified as clothes, so-called "Internet of Clothing" (Evrythng, 2017) term reveals which is claimed as the future of fashion. This means that any fashion product can become a data generating object that creates opportunity for new user experiences. "Digital born" products will take place as in the following scenarios:

> *Imagine a world in which your t-shirt tells you its carbon footprint. Your sweater tells you how to recycle it. Your jacket lets you review it, and then shares that with your social networks (…) Your football jersey is your ticket to the game and lets you pre-order halftime drinks with a special offer* (Evrythng, 2017).

Internet of Things

The Internet of Things (IoT) is a rapidly emerging topic of technical, social, and economic significance. Products, goods, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way people live. Projections for the impact of IoT on the internet and economy are considerably promising, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025 (Rose, Eldridge, & Chapin, 2015).

As technology has progressed, new categories of objects have been created including telephones, radios, televisions and smartphones. Even though these devices tended to start out very expensive and gradually come down in price (McEwen & Cassimally, 2014) and eventually cause the current tendency of "smartness" in everyday life that play key role in the IoT term that represents "a vision in which internet extends into real world embracing everyday objects" (Mattern & Floerkemeier, 2010). McEwen and Cassimally (2014) summarized components of IoT as an equation of "Physical object + Controller, sensor, and actuators + Internet". Briefly, this "Thing" present in the real world, inside home or worn around the human body receive inputs from the environment and transform into reports using internet. An example scenario in this context is given in the following:

> *The alarm rings. As you open your eyes bleanly, you see that it is five minutes later than your usual wake up time. The clock has checked the train times online, and your train must be delayed, so it lets you sleep in a little bit longer (as cited in McEwen & Cassimally, 2014).*

Several reports demonstrate that companies across various industries have IoT on their radar and the market spend is growing largely focus on the following key areas - smart communities/smart cities, energy/utilities, agriculture, transportation, healthcare and home monitoring (Verizon, 2016; Rose, Eldridge, & Chapin, 2015). Particularly, incorporation of IoT and smart cities play an important role in developing future cities and communities, (Eremia, Toma, & Sanduleac, 2017) and ensuring sustainable development (Sujata, Saksham, Tanvi, & Shreya, 2016). In smart city context, "smart" refers to technological and inter-connected, but also sustainable, comfortable, safe (Sanseverino, 2014), briefly liveable and efficient (Sujata, Saksham, Tanvi, & Shreya, 2016).

Cities actively developing strategies towards the goal of becoming "smart" as Sujata, et al (2016) identified 6 significant pillars: Social, Management, Economic, Legal, Technology and Sustainability. Smart city is not just about a few enthusiasts but all citizens. It is about daily chores, everyday life and altering attitude since social and sustainable factors include within itself. Eremia, et al (2017) also defines smart city by sustainable development indicators of communities for ensuring urban services and quality of life such as energy, environment, health, safety, shelter, solid waste, telecommunications and innovation, transportation, urban planning, waste water and so forth. Regarding these dimensions, the smartness of city is created by interconnecting digital networks and integrated into systems, sensors and sensorial organs, as well as software tools (Eremia, et al, 2017). In this matter, IoT concept cause easier use of the databases and software applications for more efficient cities and providing better quality of life for citizens.

GAP OF KNOWLEDGE, PROBLEM STATEMENT AND OBJECTIVES

There is an urgent need for global action for shaping the future to contribute sustainability. In this matter, **focusing on behavioural change that is hidden in everyday lives of people is a key step. Moreover, future concerns** must establish a bond between future tendencies such as developing technology. Fashionable technology overlaps different areas, such as fashion, technology, science. While fashion has limited practices on sustainability, technology has four main topics in fashionable wearables market. The main intention is to incorporate these areas to specifically promote sustainable behaviour. In this context, how and to what extent new projects of fashionable technology (e.g., fashionable wearables connected with IoT) can be used for behavioural change, leading to sustainability, such as promoting daily routines in city lives, mobility (e.g., biking, walking) remains unexplored. Regarding to future tendencies of society such as technology and "smart" solutions, as well as the quality of life and sustainable concerns embody in societal challenges, mission-based approaches and more effective and collaborative contributions in multiple fields are required.

General aim: *How can fashionable technology, in smart cities, be part of this sustainable future missions?*

Research questions:

- *How can fashionable technology contribute for behavioural change considering sustainability in daily lives?*
- *What are the un/sustainable behaviours in city life that smart fashion product will take part to motivate people?*

In this sense, the main objective of this research is to contribute for sustainability through behavioural change

in cities, by means of fashionable technology.
To achieve the proposed objective the following secondary objectives are:

1. To assess current acceptance/compliance levels regarding sustainability in urban contexts;
2. To examine the main goals and features of Smart City with IoT incorporation;
3. To understand/describe the users' behaviours towards sustainability and the reasons underlying it (e.g., attitudes/motivations, expectations, fears, obstacles) in diverse manifestations in their city life (e.g., choice of transportation, waste management…) in order to find the need/role for smart fashion product for this purpose;
4. To identify a scenario for intervention (case study);
5. To propose new design solutions (e.g., clothing line, modular garment, material, embedded/clipped substantial technology) and approaches for the identified case scenario;
6. To develop a prototype of smart fashion product for testing with users in real-world context.

PROPOSED METHODOLOGY

To meet the proposed objectives efficiently, a mixed methodology will be used, which is one form of triangulation that allows researchers to obtain data from range of sources (Crouch & Pearce, 2012). The methodology shall follow a User-Centred Design (UCD) approach.
Quantitative data is suited to analyse cause-and-effect and used for describing, simplifying and generalizing things and, additionally, to test or verify an existing theory. Examples of quantitative data are those gathered from ergonomics and usability tests, structured surveys, scales, performance metrics (e.g., amount of times used, average duration of use), and observation checklists, among others.
Qualitative data, on the other hand, is suited to explain complex problems, particularly involving people's personal experiences. Examples of qualitative data are those related with the understanding users' behaviours, the reasons underlying it and users' perceptions, among others.
To conduct this study, regarding the objectives mentioned, the proposed methodology will be divided into five phases:

1. *Knowledge Expansion and Analysis of Reference Situations*

Objective: To update and deepen the theoretical and scientific knowledge regarding the field and themes of the research.
Fashionable Technology, IoT and Smart Cities, as well as sustainability concepts need to be examined to identify the sustainable intentions in urban contexts, main limitations and difficulties of technology should be defined based on documentary research and expert reviews. Construction of an overall portrait of the smart cities and IoT, including the definition of requirements (e.g., target sustainable behaviours) will provide an assessment of sustainable intentions by potential users for the next phase. Also, systematic literature review provides a guidance for empirical data, functioning as a starting point for conducting field/survey research.
The following tasks are involved in this phase (3 months duration):

- Review of the literature and analysis of organizational documents (i.e. agendas, announcements, written reports of events), administrative documents (i.e. proposals, progress/annual reports) and other formal studies to understand the intentions and on-going projects in Smart City and IoT, sustainability and Fashionable Technology;
- Expert interviews to identify the main limitations and difficulties of technology, smart cities, fashionable technology through;
- Characterize sustainable behaviour strategies and identify target sustainable behaviours as a citizen and as a user of smart fashion product regarding needs and demands.

2. *Field/Survey Research*

Objective: To evaluate the target users' current sustainable behaviours and the underlying reasons for their actions, in their city life (e.g., choice of transportation, waste management…) to find the role/need for smart fashion products.
Both qualitative and quantitative data gathered from in-depth interviews and questionnaires with scales will be used to better understand the users/citizens' expectations/needs and to document people's characteristics, opinions, attitudes and previous experiences. This information is an important starting point for the creation of personas and scenarios for conceptual design. At the end of this phase, both target users and the type of smart fashion product (e.g., womenswear, garment, accessory, product line, …) will be defined. According to the identified users and solutions, conceptual design phase will be proceeded.
The following tasks are involved in this phase (5 months duration):

- Adapt/enhance validated interview/questionnaires to better understand user's behaviours, atti-

tudes, everyday life actions in city life and arrange a pilot interview/questionnaire related with analysis in first phase;
- Conduct in-depth interviews to examine what participants feel about certain issues in their daily lives concerning sustainability;
- Conduct a survey by designing written and online questionnaires to measure the attitude of people as a citizen and as a consumer of smart fashion product. Likert-type and behavioural scales will be used;
- Statistical analysis (with SPSS and MAXQDA) of the quantitative and qualitative data;
- Identify target users, analyse their needs, demands, attitudes and motivation, everyday life decisions;
- Identify smart fashion product or product line in every aspect regarding the target user.

3. *Ideation and Development of Conceptual Design*

Objective: To develop personas and scenarios for integrating the design solutions and approaches that consists of the relationship between the smart city and the user.
In this phase, proposals of fashionable technology products for sustainable behaviour will be defined for the smart city case, and conceptual design ideas will be developed. Based on the information obtained in the previous stages, according to specified personas and scenarios, guidelines for the smart fashion product will be proposed considering the following design considerations (Seymour, 2009):

- body ergonomics and wearability (e.g. placement, form, sizing, comfort, heat, movement);
- perception of user (e.g. human behaviour, look and feel) In this consideration, design strategies for sustainable behaviour (e.g. Petersson, 2016) which will be adapted and improved according to previous findings from the questionnaire and interviews;
- functionality (e.g. modular construction for multiple purpose);
- technology (e.g. IoT, sensors, embedded/clipped);
- materials (e.g. interactive or reactive materials/textiles, e-textile, washing/cleaning);
- energy (e.g. batteries, solar, kinetic);
- recycle (e.g. ecological, disposal information);

The following tasks are involved in this phase (6 months duration):

- Creation of personas and scenarios (sketching, brainstorming, organizing);
- Definition of a list of requirements that conceptual smart fashion product design must meet. Topics such as materials, production techniques, technological sufficiency, will be explored;
- Conceptual design of smart fashion products following the design considerations by Seymour (2009).

4. *Design Production and Prototyping*

Objective: To develop a detailed design and construct the prototype of smart fashion product to afford the observation of user performance in real-world context.
The multiple alternative conceptual design ideas, developed in the previous phase and meeting the requirements, will be used as a baseline for continuously growing detailed designs, starting from wireframes (including user interface objects and data elements), to semi-functional sewn prototypes to test for fit, functionality and style. In this phase, smart fashionable technology-based product will be designed and constructed including interface, and software prototyping.
The following tasks are involved in this phase (4 months duration):

- To obtain materials (e.g., fabric, textile accessories, electronic devices, ...) and other requirements (e.g. sewing atelier, textile/technology lab, ...) previously defined;
- Technical design of the smart fashion product (pattern-making) and construction;
- Interface design of the smart fashion product and other interconnected devices;
- Creation of a prototype of the smart fashion product (with collaboration of software, textile engineers, interaction designers and other experts in related fields);
- Analyse and test the prototype against the listed design considerations/requirements.

5. *Evaluation and Conclusion*

Objective: To test the validity of the prototype by user tests and perceptions.
Since the proposed smart fashion product and the smart city are still in progress concepts, the effects on the sustainable behaviours adoption will be measured indirectly. According to Fogg (2009), sufficient amount of motivation, sufficient ability that means the simplicity of the product/service/system and effective trigger are needed for a target behaviour to happen. In this sense, behavioural change can be measured by assessing motivation through structured interviews, and simplicity and usability of the product via user perspectives.
The following tasks are involved in this phase (5 months duration):

- Evaluate and validate the prototype by measuring motivation through structured interview/questionnaire and simplicity through conducting iterative usability tests;
- Statistical analyses of qualitative and quantitative data about user perspectives, motivation and ability;
- Conclude reporting and determine future works.

FINAL REMARKS AND FURTHER WORK

Regarding future concerns of sustainability as well as quality of life, and future tendencies of smartness because of rapid evolution of technology, mission-based approaches and more improvements in multiple fields are required. Fashionable technology is in the position of several overlapping areas including fashion and technology. The main intention is to incorporate these areas specifically for promoting sustainable behaviour, which is the key challenge to contribute sustainability. In this matter, this research proposes a hypothesis that fashionable technology is able to promote sustainable behaviour. As a further work, this hypothesis will be tested during two years of research plan as detailed in the methodology section.

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R. Journal Paper: A Literature Review of Sustainable Behaviours Asserted in the Context of Everyday Life in Cities

A Literature Review of Sustainable Behaviours Asserted in the Context of Everyday Life in Cities

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ABSTRACT

The work presented in this paper is a part of a doctoral research in Design, which aims to promote sustainable behaviours in everyday life through the use of fashionable wearables. The comprehension of what kind of behaviours can be considered as being sustainable is needed for backing the design solutions including the wearables. Thus, a literature review was conducted, followed by a content analysis, intended to explore and frame those behaviours. Akenji and Chen's (2016) framework was chosen and modified to structure the type and domains of sustainable behaviours. The results suggest a trend for the sustainable behaviours to be associated with topics in the domain of housing, food, goods consumption and mobility. Furthermore, "effuse" behaviours that target positive impacts such as reusing, recycling, conserving and eco-innovative solutions are also frequently suggested.

Keywords: Sustainability, Sustainable Behaviour, Sustainable Lifestyle, Behaviour Change

ABSTRATO

Este artigo é parte de uma investigação de doutoramento em Design que visa promover comportamentos sustentáveis no dia a dia através do uso de moda inteligente. A compreensão de quais os tipos de comportamentos que podem ser considerados sustentáveis é necessária para apoiar as decisões de soluções de moda que incluirão "wearables". Assim, foi realizada uma revisão de literatura, seguida de uma análise de conteúdo, com o objetivo de explorar e enquadrar os comportamentos considerados sustentáveis na literatura. O enquadramento de Akenji e Chen (2016) foi escolhido e modificado para estruturar o tipo e os domínios dos comportamentos sustentáveis. Os resultados sugerem uma tendência para associar os comportamentos sustentáveis a tópicos nos domínios da habitação, alimentação, consumo de bens e mobilidade. Além disso, comportamentos "efusos", que visam impactos positivos como a reutilização, reciclagem, conservação e soluções eco-inovadoras, também são frequentemente sugeridos neste contexto.

Palavras-chave: Sustentabilidade, Comportamento Sustentável, Estilo de Vida Sustentável, Mudança de Comportamento

1. INTRODUCTION

The promotion of sustainable habits, having people and their behaviours as a starting point for the change, has been suggested as one of the main keys to achieve sustainability (Lilley, 2009; Sustainable Consumption Roundtable, 2006; Bhamra, Lilley, & Tang, 2011). Previous studies developed design strategies, theories, models and frameworks to influence sustainable behaviour and lifestyles. Most of their approaches were mainly focused on "how"

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to persuade users to behave in a particular way and mainly from the point of view of behaviour change models (Spencer, 2014). The majority of the ways used to implement behaviour change models/ theories comprehend the perception and psychology of users in order to persuade them. Although these are beneficial and significant concerns, a gap of knowledge was found on understanding "what kind" of sustainable behaviours needs to be explored.

This paper presents findings of a literature review that is part of doctoral research aiming to support the design of fashionable wearables, which can work as active elements in the promotion of behaviours considered more sustainable, as part of a system in smart cities context. We assume that the combination of functionality and seduction power of fashion products design, when combined with Internet of Things (IoT) Technology, can make an important contribution to sustainability.

One of the first methodological steps was to grasp what is the current understanding of sustainable behaviours. We were looking to understand things such as, what kind of behaviours can be considered as sustainable and which behaviours in the city life might have more negative impact. These data would help us to find how to match fashionable wearables with the identified behaviours. In this sense, the main question that this paper tries to answer is - "Which type of sustainable behaviours could be better options for the case of behaviour change studies targeting sustainability?".

1.1. Human Behaviour and Lifestyles in the context of Sustainability

Human behaviour refers to a range of actions made by humans and that is typically influenced by several determinants (Hemakumara & Rainis, 2018). These independent determinants are, according to the Theory of Planned Behaviour (Ajzen, 1991), "attitudes towards behaviour", "subjective norms" and "perceived behavioural control" and they contribute to the behavioural intentions that inform later actions. Behaviour is mainly a response to various stimuli or inputs, unconscious or subconscious, voluntary or involuntary. When these responses or actions focus on the overlap of environmental, social and economic concerns, it can be considered as sustainable behaviour.

Manning (2009, p. 7) argues that the transition to sustainability introduces new ideas and behaviours as well as ambiguity. Even though people are optimistic about sustainability, they are uncertain about how to behave in a sustainable way and implement it in their everyday lives. They are either in need of social proof that convinces them that the effort serves the purpose or have difficulty in changing some social norms. In other words, people's rational minds may know that the change is needed, however it is not always the rational minds that drive the behaviour. People think in two different cognitive systems of reasoning: A rule-based which is reflective, conscious, self-aware, and an associative system which is automatic, unconscious, sensory-driven (Sloman, 1996; Thaler & Sunstein, 2008). Manning (2009) addresses the problem of sustainable behaviour as having little appeal to the associative system:

> *Consider a behaviour like biking to work: a person's rule-based system thinks it's a great idea because of all the benefits (health, money savings, fitness), but his associative system responds with a definitive "No way!" perhaps because it just can't handle the idea of walking into the office with "helmet hair." One way to empower sustainability is to make sustainable actions appealing to the associative system (…) A second strategy is to get the attention of the rule-based system so that it can assert itself against the associative*

system's rejection of a sustainable action ("Helmet hair is really no big deal. We're biking!") (Manning, 2009, p. 3).

Additionally, many unsustainable actions are considered perfectly normal such as driving alone, living in a very large house that requires unnecessary heating, eating foods that have travelled long distances, constantly shopping for new products. However, sustainable behaviours such as buying second hand products or taking short showers are seen as lower status or undesirable (Manning, 2009; Sadalla & Krull, 1995). Many other behaviours that take place in everyday life, compose lifestyles. Plus, lifestyles are representative of how humans interact with each other in the decisions and choices they make that can have strong impacts on the environment and community itself.

Lifestyle refers to a pattern of consumption reflecting people's choice in terms of spending time and money, usually attitudes and values come attached to these behavioural patterns (Solomon, Bamossy, & Hogg, 2006). Patterns of choices or demands based on lifestyles mostly consist of many components that are shared by others in similar social and economic circumstances. However, each person provides a unique "twist" to this pattern and makes each lifestyle unique. Solomon, et al (2006, p. 558) give this example: "a 'typical' student may dress much like his or her friends, go to the same places and like the same foods, yet still indulge a passion for running marathons, stamp collecting or community service, activities which make him or her unique". This unique twist which can be rephrased as seeking for individuality, might come into surface in various activities, interests or opinions. These three categories of variables - activities, interest and opinions (AIOs) - are suggested as the dimensions to assess lifestyles. Wells and Tigert's (1971) psychographic research argues that one can understand lifestyle "by discovering how people spend their time (activities), what they find interesting and important (interests) and how they view themselves and the world around them (opinions), as well as demographic information" (Solomon, Bamossy, & Hogg, 2006).

Creating sustainable lifestyles, which means rethinking the ways of living and individual actions (UNEP, 2011), is quite important to empower sustainable behaviour. Creating this particular lifestyle also means rethinking how people organize their daily life, altering the way of socialization, exchange, share, educate and build identities. It is about transforming the society towards more equity and living in balance with the natural environment. "Everyday life" or "lifestyle" expressions are mostly highlighted in various studies that contribute to sustainability in terms of behaviour (Manzini & Jegou, 2003; UNEP, 2011; Petersson, 2016; Thieme, et al., 2012; Barr & Gilg, 2006; Marchand & Walker, 2008). Furthermore, many concerns in the base of encouraging sustainable behaviour and altering lifestyles towards an environmental base are considered in the context of urban life (Manzini & Jegou, 2003; UNEP, 2011) as well as inside and around the home (Barr & Gilg, 2006).

2. METHODOLOGY

To better understand, examine and characterize sustainable behaviours in the context of everyday life in cities, both quantitative and qualitative data were gathered from a literature review, semi-structured interviews and observations. However, this paper only presents findings from the literature review part, which was conducted into 4 phases:

(1) Knowledge expansion and selection of publications,

(2) Review for framework selection,

(3) Data collection, framing and content analysis,

(4) Interpretation of results.

The following databases were selected: EBSCOhost, Elsevier, ScienceDirect, Google Scholar, OATD and bibliographic catalogue of IADE Library. The keywords used were: "sustainable behaviour", "sustainable lifestyle", "sustainable actions", "design for sustainable behaviour" and "design for behaviour change". Academic journals, conference materials, reports, books and dissertation/thesis were the type of sources included.

After manual sorting, evaluating titles and abstracts, 41 publications were selected. Among these publications and after analysing the alignment of the titles with the objective of the research, the availability of sustainable behaviours in the form of strategies, case studies, scenarios and the examples given in theoretical background, selecting one work of the same authors (directly proportional the amount of proposed behaviours), 10 publications remained (Table 2).

***Table 2** List of sources*

Sources	Type of source	Brief topic
(Akenji & Chen, 2016)	Report	Shaping sustainable lifestyles - Framework
(Thieme, et al., 2012)	Article	Designing persuasive system to promote sustainable lifestyles – User study
(Bhamra, Lilley, & Tang, 2011)	Academic journal	Designing for sustainable behaviour - Case study
(Wever, van Kuijik, & Boks, 2008)	Academic Journal	User-centred design for sustainable behaviour – Case study
(UNEP, 2011)	Report	Recommendations to develop efficient sustainable lifestyles based on survey
(Petersson, 2016)	Report	Strategies to enable sustainable choices in everyday life – Guideline
(Monroe, 2003)	Academic journal	Encouraging environmentally responsible behaviours – Review / Theoretical Study
(Manning, 2009)	Report	Psychology of sustainable behaviour – Theoretical study
(Lidman & Renström, 2011)	Dissertation	Design for sustainable behaviour – Framework / Applied study
(Manzini & Jegou, 2003)	Book	Promoting sustainable everyday life by urban life scenarios – Framework / Case study

2.1. The Framework – Everyday Life Domains

Everyday life or daily life is briefly "what we do every day" (Manzini & Jegou, 2003, p. 63) and consists of series of actions conducted by people and eventually is an output of unique lifestyles. These two terms "lifestyles" and "everyday life" were interchangeably used in the previous studies. In this study, we prefer to use the term "everyday life" because lifestyle has set of complex drivers such as personal situation, external social and economic conditions, as well as physical and natural boundaries (Akenji & Chen, 2016). The focus is based on promoting behaviours, therefore "what we do everyday" or "how we act everyday" is found more relevant in this context. Existing literature on promoting sustainable everyday life are

also linked with city life. Increasing population towards urban areas (United Nations, Economic & Social Affairs, 2016), as well as individuals' "hope for a better life" (Eremia, Toma, & Sanduleac, 2017) and "gain access" (Etezadzadeh, 2016) to necessities were considered as the reason.

The first example in the city context was found in Manzini and Jegou's (2003) sustainable scenarios in urban life. In that project, the point of reference was "the daily dimension of human's existence" starting from local environment. The project offered possible scenarios and practicable alternatives by answering the question: "What might life be like in sustainable society?". Scenarios which promote sustainable urban life, were divided into different topics which are listed as "eating", "things", "work", "cities", "energy" and "vegetation". Another example was found in UNEP's (2011) Global Survey that asked young adults, living in urban areas from 20 countries, to examine their current lifestyles. The survey's main objective was to analyse young adults' perceptions and attitudes in everyday life as well as the visions of sustainable lifestyles, to encourage participation of sustainable scenarios, and to develop policy recommendations, focusing on opportunities, actors and responsibility. Sustainable lifestyles were divided into three major climate-related areas: "mobility", "food" and "housekeeping". "They were also three major consumption areas that have great impacts on environments and societies, and need to be looked at closely to tackle global challenges such as climate change" (UNEP, 2011, p. 18).

Recently, another UNEP report was proposing "evidence-based framework design" to enable lifestyle choices that contribute to sustainability (Akenji & Chen, 2016). The report argued that there were encouraging signs that society understands the impact of daily choices and the various ways of actions, models and surveys are helping people to live more sustainable lifestyles. However, there was still the need of a holistic vision of what constitutes a sustainable lifestyle. In this matter, based on consumption categories and groups of products that have the highest environmental impacts, as well as "equally problematic" social impacts, the key domains proposed were "food", "housing", "mobility", "consumer goods" and "leisure". Additionally, water, energy, and waste were not addressed in isolation but as cross-cutting elements that affect and were affected by almost every lifestyle domain (Akenji & Chen, 2016, p. 5).

Regarding these three approaches (Table 1), the main focuses were observed as daily activities inside home, eating habits and mobility. However, some dimensions were found unnecessary as they might be considered as sub-element under some proposed titles. Furthermore, considering consumption as a high impact of daily basis, and leisure time activities were also important as people spend considerable time as leisure.

Table 1 *Findings of key domains based on different sources*

Key Domains of Everyday Life	Source
Eating (food preparation) **Things** (taking care of the house and household objects) **Work** (the organization of activity networks for work, study, entertainment, socializing) **Cities** (urban mobility) **Energy** (energy production and management) **Vegetation** (the creation of urban and non-urban green spaces)	"Daily dimension of human's existence" (Manzini & Jegou, 2003)

Housekeeping (Being at home) **Food** (Getting some food and eating) **Mobility** (Getting around, getting out)	"Major climate-related areas" (UNEP, 2011)
Food (What we eat/drink, how it is produced, processed, provided and disposed) **Mobility** (How/how often we travel) **Housing** (How/Where we live, what is used to build, heat and cool) **Consumer goods** (The type/quantity of products we buy, how we use and how often we replace) **Leisure** (How we spend leisure time, choice of tourism destinations, activities, how we use facilities)	"Key lifestyle domains" (Akenji & Chen, 2016)

For our research, Akenji and Chen's (2016) approach was chosen as a framework due to its recency, practicality and holistic point of view. This framework was not used only for proposing the domains of daily life, but also the components of "everyday sustainability actions" (REDuse), which are formed as Refuse, Effuse and Diffuse. "Refuse" targets negative-impact activities and actions by individuals/households to avoid or reduce unsustainable practices. "Effuse" targets positive impact activities by individuals/ households that are sustainable. Finally, "Diffuse" collaborative engagement actions with wider communities that provide solutions and reduce environmental impact. These components are used to categorize reviewed behaviour types in terms of sustainability. On the other hand, lifestyle domains are renamed as "everyday life domains" and the behaviours found on previous cases which are not considered in any of these domains, are framed as "Other".

3. RESULTS AND DISCUSSION

Framing different target sustainable behaviours according to the selected framework enables a number of observations to be made (Table 3).

***Table 3** Framed behaviour types and frequencies from the sources*

Everyday Life Domains	***Refuse*** *Boycott, Avoid, Reduce*	***Effuse*** *Eco-innovate, Do-it-yourself Reuse, Conserve*	***Diffuse*** *Share, Collaborate, Localize Evo-innovate*
Food	• Avoid food waste**** • Distinguish the 'sell by', 'best before' and 'use by' dates (some foods are safe to consume even after use by dates* • Avoid overconsumption of animal products (red meat)* • Stop eating, selling, serving giant prawns* • Reduce impact on global warming by not drinking heated beverages*	• Choose local, fresh, in-season and/or organic produce over exotic and out-of-season options**** • Urban gardening, urban farming, self-producing vegetables and fruits*** • Eating more fruits and vegetables*	• Initiate healthy, delicious and balanced low-impact meals at work canteen/schools* • Participate in local farmers market* • Support and invest in Food coop* • Food sharing, extra cooking for others to take away** • Guerilla gardening*
Mobility	• Avoid/reduce private car use; single-occupancy driving****	• Public transport as part of or all the way to work** • Walk or cycle for very short journeys such as the ones to local convenient store* • Using bike in the city****	• Car-pooling scheme, car club*** • Car-sharing for work commute*** • Teleconferencing facilities instead of long-distance face-to-face meetings*

		• Using energy efficient vehicles**	
Housing	• Avoid large houses (with low occupancy)* • Avoid unnecessary product promotions/discounts* • Avoid multiple/large electronic and electrical appliances (TV, fridges)* • Reduce fridge door opening times* • Reduce energy consumption****** • Reduce household wastes* • Switch-off the devices you don't use instead of stand-by*	• Home insulation** • Energy and water efficient behavior**** • Opt for renewable energy option** • Construct "passive houses" (reduce building's eco footprint)* • Use energy efficient light bulb* • Recycling in the household* • Correct dosing of cleaning agents (toothpaste, detergent)*	• Initiate/join a (neighbourhood) tools library or rarely used household tools/appliances** • Collective laundry washing in buildings* • Organized help-network, do-it-yourself support* • Neighborhood co-operation/exchange services*
Consumer goods	• Avoid one-time use products (plastic bags, razors, plastic cups, single use cleaning products)* • Stop buying goods that comes from slave labor* • Stop buying goods that causes destruction of environment*** • Use less washing detergent then recommended (safety margins)* • Decrease the need for purchasing new clothes** • Decrease amount of waste*	• Repair* • Recycle**** • Purchasing green products based on degree of their environmental friendliness** • Use reusable sanitary protection instead of disposable ones* • Alter consumption habits* • Reuse/repair clothes*	• Give away old but still usable items (clothing, electronics, furniture)* • Rent less-frequently used goods instead of buying*
Leisure	• Boycott tourism to sensitive biodiversity hotspots*	• Choose low impact yet enjoyable activities/experience for leisure (gardening, visit parks, local museums, theatre, cycling, volunteering, family party/picnic)* • Put up bird boxes* • Plant sea oats* • Re-use towels at hotels* • Clean the beaches from rubbish* • Keep streets clean/ nudging litter into the bin*** • Look up information, reading articles/books*	• Participate events and courses for lifelong learning** • Actively participate in leading environmental initiatives*** • Be kind and caring to all living things*
Other		• Recycle papers and cups at work* • Count wildlife populations* • Promoting prescribed fire* • Reduce waste in the production process*	• Make voluntary donation to charities** • Vote** • Establish mortgage criteria for energy efficient houses* • Sue a polluter* • Use legal system to force compliance with environmental law* • Protest, speech-making, letter-writing* • Invest in environmentally responsible companies*

			• Lobby to motivate others*

**The frequency of suggested behaviour*

The next frequency chart (Figure 1) offers a graphical view of the different approaches grouped by everyday domain.

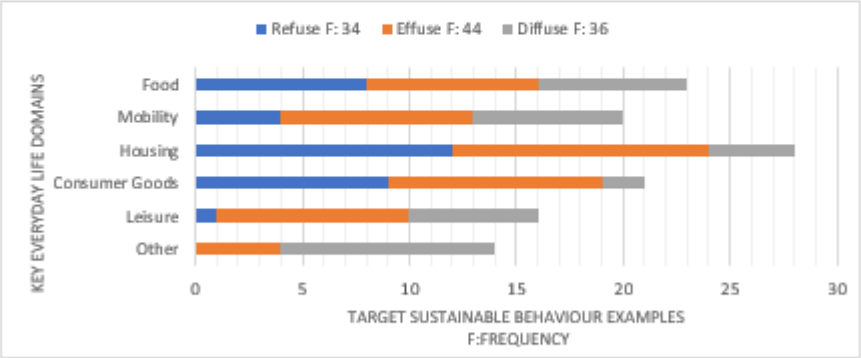

Figure 1 *The frequency of target behaviour domains*

Firstly, the data suggest that the largest number of target behaviours is found in the housing domain, especially in the form of refuse and effuse. In other words, collaborative forms of behaviours are less suggested comparing to others. When examined in detail, referred behaviours are mostly related with energy consumption such as: "switch off devices", "reduce fridge door openings", "use energy efficient light bulbs" and so forth. The next domains to be more frequently indicated are food, consumer goods and mobility. The domain of leisure activities and the behaviours tagged as "Other", which are not concerned any of these key domains, are indicated at the least.

Secondly, the most suggested behaviours are: "reduce energy consumption", "avoid food waste", "choose local, fresh, in season and/or organic produce over exotic and out of season options", "use bike in the city", "energy or water efficient behaviour" and "recycle". The majority of the frequently proposed behaviours are curtailing or ending a certain type of behaviour or substituting a new for an old behaviour.

Thirdly, the most suggested behaviours are found in the form of "effuse" behaviour which is mainly summarized as more efficient and innovative solutions for a particular behaviour type such as conserving, reusing, recycling or do-it-yourself suggestions. This demonstrates that the suggested target behaviours, which are also defined as sustainable behaviours, are proposed to promote more sustainable behaviour. Behaviours such as less goods consumption or less clothes purchasing are more efficient than recycling or repairing these artefacts since waste is an unwanted output. However, both type of behaviours are considered as sustainable behaviours, which can be understood in the sense that any kind of step towards sustainability is welcomed.

Fourthly, it is observed that some behaviours, such as "reduce energy consumption", "energy or water sufficient behaviour", "stop buying goods that causes destruction of environment", are being pointed out without clarifying a specific source or target, which might be considered as vague. On the contrary, some examples are clarified the generalized statements. For example, "Reduce fridge door opening" is focused on only one specific interaction with an industrial product instead of claiming reduce energy consumption. Another example might be given as "stop eating, selling, serving giant prawns" which put a finer point on the "goods that causes environmental destruction" and gives a specific focus on a particular seafood.

Finally, some behaviours that are defined as "political behaviours" (Monroe, 2003) or "civic actions" (Manning, 2009) such as voting, protesting, "ecosystem behaviours" (Monroe, 2003) such as putting up bird boxes, planting sea oats or behaviours which are specific to expertise or workplace such as reducing waste in production process are categorized as "Others". Nevertheless, it is observed that behaviours are also related with energy consumption, waste management or avoiding destruction of environment which are similar topics in other domains of everyday life.

4. CONCLUSION

Identifying the behaviours mostly claimed as sustainable was the main intention of this research, intended support an informed decision about which behaviour(s) to select in order design fashionable wearables. Based on the gathered findings the research can now proceed to the next step, which consists in collecting the user perceptions about this problematic. Domains of everyday life and type of behaviour framing were considered for the identification.

This research has explored and juxtaposed the understanding of sustainable behaviours through a content analysis of the reviewed literature. A number of studies were found presenting frameworks or seeking the answer on how to design, persuade, motivate, or encourage users in changing their behaviour. We could gather examples of strategies, frameworks or guidelines from them, which are being suggested as adequate for this purpose. However, we also found many statements that do not clearly define the type of behaviour being considered as sustainable. Thus, such an undefinition required a subjective interpretation, which we based on a feature of the product designs or case studies suggested in scenarios.

The conclusions of this study are limited by the following aspects: the articles included in the analysis are restricted to particular databases; the keywords used in the search of publications; the framework used to formulate the sustainable behaviours in the lens of everyday life.

As suggestion for future studies, we highlight the possibility of deepening the analysis and the inclusion of experts, as well as the conduction of focus groups with a range of stakeholders.

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S. Book Chapter: User-Oriented Challenges of Smart Mobility: An Analysis of Focus Group to Identify User Behaviour (Accepted Manuscript)

User-Oriented Challenges of Smart Mobility: An analysis of Focus Group to Identify User Behaviour

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Abstract. Mobility in big cities has been pointed as the cause of growing unsatisfaction of citizens with a direct effect in their quality of life and overall sustainability of these places. Recently, due to new technological developments, cities are becoming "smart" and smart mobility has growing importance. However, little is known about smart mobility effectiveness and how it may positively affect sustainability in cities daily life. This study aims to understand the potential users' behavioural intentions about their mobility choices and to identify which are the biggest perceived obstacles that may prevent them to take more sustainable mobility decisions. Six focus groups were run with students and young adults that were living in different districts of Lisbon intended to discover their expectations, problems and needs regarding mobility. A card-sorting task was used to measure their preference and satisfaction levels about a set of options. Fifteen topics of major demand and nineteen problems were identified. Results also confirm both positive and negative impacts on preference and satisfaction levels of users on current city life and smart possibilities of mobility. These results provide a useful basis for the ideation phase, as part of a design process that aims to find solutions able to motivate users towards more sustainable choices.

Keywords: Sustainable Behaviour, Smart Mobility, Human-Centred Design, Focus Group, Card Sorting

1 Introduction

This paper presents findings from a user research phase, run as part of a doctoral study aiming to promote sustainable behaviours in everyday life in large cities. In particular, we are interested in exploring the potential of fashionable wearables for promoting sustainable mobility behaviours, in the context of smart cities.
This study follows a Research Through Design approach (Frankel & Racine, 2010). Thus, the findings gathered from this phase are expected to work as a keystone to

back the development of alternative designs that can be considered adequate solutions for the problem of current low adoption of sustainable mobility behaviours in large cities. As mobility choices have an impact on citizens' behaviours and vice versa, this study is also about how to design for behaviour change.

The transition to sustainability introduces new ideas and behaviours as well as ambiguity (Manning, 2009). Although people are optimistic about sustainability and want to live in a way that treats ecosystems we depend on with care and respect, most often they found themselves engaged on unsustainable daily behaviours that have negative environmental impacts. The reasons for this are diverse. In some cases, they are uncertain about how to behave sustainably and/or how to implement it in their everyday life. In other cases, they might either need social proof that convinces them the effort serves the purpose or they just need some help to change some social norms. For example, many unsustainable daily actions, such as driving alone, still are well accepted by the community while alternative options (e.g., share the ride or use public transports) are seen as signals of lower status and avoided due to their negative connotation (Manning, 2009; Sadalla & Krull, 1995).
Despite people's rational minds know that change is necessary, we know that human behaviour is not always drive by reason (Manning, 2009). Also, when confronted with rational arguments against or questioning their actions, people are very good at finding strategies to avoid uncomfortable feelings and find excuses without changing beliefs or actions (Festinger, 1985). Previous studies on the common excuses that allow people to feel justified not behaving desirably (e.g., quit smoking) (Festinger, 1985), perform a pro-environmental behaviour (Manolas, 2015) suggest that the argument used is that the "desirable" action is not appealing to the associative system. Thus, regarding the topic we are exploring, it is legitimate to assume that people want to be sustainable, however, they think their current life situation does not allow them to behave accordingly. Also, they may not be either able to see an immediate consequence of their behaviour change, sometimes aggravated by witnessing other people behaving in an opposite direction, giving them the idea that their effort was useless. Altogether, these arguments give support to a "valid" excuse, turning their unsustainable actions "reasonable" at their point of view.
Many of these "reasonable" behaviours are currently taking place in cities, with strong impacts on the environment and the community itself, which is foreseen to aggravate in a near future due to the increasing pressure for urbanization, as it is expected that nearly 60% of people will live in urban areas by 2030 (United Nations, 2016). The need for urbanization is addressed as "hope for a better life" (Eremia, Toma, & Sanduleac, 2017) and "hope to gain access" to necessities of life, knowledge, other people, and some other opportunities (Etezadzadeh, 2016). However, people will need to deal with much more complexity in urban life such as overpopulation, pollution, poor infrastructure, depletion of sources, and so forth.

To deal with these issues, modern cities are increasingly becoming "smart" thanks to networks of Internet of Things (IoT), requiring new and distinctive codes (Sanseverino, 2014) that take into account not only the information technology capa-

bilities and limitations but also sustainable issues. Urban mobility gained importance in the context of smart cities, considered one of its main pillars, and one aspect with a stronger impact on its sustainability. According to Giffinger et al's (2007) approach, smart mobility is one of the six characteristics that emphasize the accessibility of citizens, together with sustainable and innovative transportation systems and efficient infrastructure of Internet and Communication Technologies. Likewise, Sanseverino (2014) addresses the importance of smart mobility as it directly and locally affects the quality of air and the quality of life in terms of generating congestion, pollution, and preventing freedom of accessibility. Hessel (2015) emphasize the smartness of mobility and addresses smart mobility as a tool to achieve sustainable cities.
Sanseverino (2014) defines smart mobility as:

> *"The ability to guarantee a good availability of public, innovative and sustainable transportation services; the support of low environmental impact transportation means such as bikes or pedestrian routes; ruling the access to historical centres; the adoption of advanced solutions for the mobility management through info-mobility, managing the mobility of individuals within the city and towards the neighbouring areas."*

In a recent study, Lyons (2018) proposes the term "smart urban mobility", defining it as "connectivity in towns and cities that is affordable, effective, attractive and sustainable". In this definition, "connectivity" acknowledges that the physical mobility of people and goods is only one means of providing access but also considers that motor vehicles are not the only option to allow such mobility. Being "affordable" and "effective" involves understanding the differing users' needs and abilities in cognitive, physical, and financial terms about connectivity. The definition also claims concerns related to being "attractive" for everyone meaning, for example, that the mobility system must meet the needs of individuals as citizens, urban dwellers, or business owners. Finally, the achievement of all these requirements must have a long-term basis that emphasizes the "sustainable" determinant of the term.

Whereas behaviour change is quite hard to achieve, mostly due to the huge diversity of individual and situational variables, we agree that if "one cannot design behaviour, one can influence people's preconditions for acting with technology by (re-)designing artefacts; designing for behaviour" (Selvefors, Strömberg, & Renström, 2016). In this sense, motivated by a desire to design successful solutions for smart mobility that can produce a positive impact in the promotion of sustainable behaviours, and convinced that such an endeavour requires a Human-Centred Design approach, we plan and conducted a series of analysis intended to facilitate the understanding of the needs, expectations and problems of the potential users of smart cities. In this context, in this paper, we present the results of a step intended to identify the main obstacles that can prevent users from adopting more sustainable behaviours in what regards their urban mobility. Knowing the demands and problems of the users, which can generate the obstacles to adopting a given behaviour, would provide us with a strong basis for the ideation of solutions, as well as could raise topics that could be later addressed in the development of the solutions. Thus, through the accomplishment of focus group sessions, incorporating a card sorting procedure, we gathered qualitative and quantitative data about the users' demands, problems, preferences and satisfaction levels, as well

as their expectations regarding the potential impact of some given smart solutions on their future mobility choices. Focus groups are suited for idea generation as well as discovering problems, challenges, frustrations, likes, and dislikes among users and card sorting is often used to inform or guide the development of information (Baxter, Courage, & Caine, 2015).

2 Methodology

To better understand the demands and problems of users, their preferences and satisfaction levels, as well as the perceived impact of smart solutions into users' mobility choices, we organised this research into four main phases:

1. **Information:** In this phase, we accomplished a literature review to understand the state of the art about smart mobility systems, human behaviour, design for behaviour change and sustainability.
2. **Planning and preparation:** In this phase, we determined the types of data to be collected and the criteria to organise it according to the objectives of the research. Also, we prepared all the materials and procedures for the focus group and card sorting sessions. This phase also included a pilot test, which offered us the chance to do the necessary modifications/improvements before running the final sessions.
3. **Data Collection:** In this phase, we conducted six focus group sessions with a convenience sample composed by students and young adults that are currently living in different districts of Lisbon. The sessions were audio-recorded and the transcripts were subject to content analysis to assess the topics that gathered more agreement, support or disagreement between the participants. Notes taken by the observer/moderator during the sessions were also considered.
4. **Data Analysis and discussion:** There is no standard procedure for the evaluation of data collected in focus groups (Gailing & Naumann, 2018) however, the interaction between the participants is highlighted by various authors (Gailing & Naumann, 2018; Nili, Tate, & Johnstone, 2017; Onwuegbuzie, Dickinson, & Leech, 2009). Thus, we conducted a tape-based analysis to both content and interaction data, which was collected in the form of verbal (words, sentences) and non-verbal (body language and facial expressions) expressions. The tape-based analysis is wherein the researcher listens to the tape of the focus group and then creates an abbreviated transcript (Onwuegbuzie et al., 2009). We opted by this type of analysis because it allows us to focus on the research question and only transcribe the portions that assist in a better understanding of the phenomenon of interest (Onwuegbuzie et al., 2009). A content analysis performed with MAX Qualitative Data Analysis (MAXqda) software, provided us with data about the frequency that some keywords were referred by the participants. Heatmaps were created with the data gathered from the card sorting, which are a visual representation showing the most selected (hot areas) and less selected (cold areas) quadrants in which the cards were positioned by the participants, after and before the debate.

2.1 Focus Groups

Focus group is defined as "a technique involving the use of in-depth group interviews in which participants are selected because they are purposive, although not necessarily representative, sampling of a specific population, this group being 'focused' on a given topic" (Guest, Namey, Taylor, Eley, & McKenna, 2017; Rabiee, 2007) and widely used in social sciences for developing hypothesis in exploratory phases of research projects (Bloor, Frankland, Thomas, & Robson, 2002). Compared to other methods, the interactive and synchronous group discussion format allows participants to discuss, agree, or dissent with each other's ideas and to elaborate on the opinions they have already mentioned (Nili et al., 2017). Therefore, it is assumed that this method has a high potential to enhance our understanding of user behaviour. The method also enables the collection of different types of data, as well as testing underlying assumptions and research questions (Cyr, 2015; Gailing & Naumann, 2018).

Demographics

A convenience sample comprising 29 volunteers participated, which were distributed by 6 independent focus groups (5 groups with 5 participants each and 1 group with just 4 participants 4 due to a last-minute impediment from one participant).
Table 1 shows the sample demographics. The age of the participants ranged from 18 to 31+ years old. The majority of the participants were female (82,8%), with ages comprised between 21 and 23 years old (41,4%), single (62,1%), and college students. Although the majority of participants were Portuguese (48,3%), 10 different nationalities participated, allowing the comparison between these participants' former experiences in different cities and Lisbon.

Table 1. Participant demographic profiles distribution

Value	F	%	Value	F	%
Gender			**Civil Status**		
Female	24	82,8%	Married	11	37,9%
Male	5	17,2%	Single	18	62,1%
Age			**Nationalities**		
18-20 years old	6	20,7%	Portuguese	14	48,3%
21-23 years old	12	41,4%	Brazilian	6	20,7%
24-26 years old	3	10,3%	Spanish	2	6,9%
27-29 years old	3	10,3%	Turkish	1	3,4%
30-32 years old	3	10,3%	Salvadorian	1	3,4%
33 years old and older	2	6,9%	Russian	1	3,4%
Professional Status			French	1	3,4%
Student	21	72,4%	Dutch	1	3,4%
Employed	5	17,2%	Mozambican	1	3,4%
Student and employed	3	10,3%	Romanian	1	3,4%
Total (∑)	29	100%	*Total* (∑)	29	100%

F: Frequency / %: Percentage

Instruments, materials and procedure

The focus groups sessions were structured into 3 phases and were undertaken both **inside the IADE campus and in other locations in Lisbon, Portugal**. Initial demographic data were collected and open-ended questions targeting content and characteristics of the mobility system, pillars of the mobility system, their experiences in Lisbon, and comparison with other cities they lived before, were asked.
In the second phase, a mixed card sorting was conducted, both in the context of current and future mobility systems. Participants were given 10 cards representing "Modes of Mobility", which were designed on purpose for this study. They were also told they could add more if wanted. The cards depicted current and planned modes of transportation, examples gathered from smart mobility projects, reports, and other sources covering both motorized and non-motorized, public and individual means of transport (Chow, 2018; Perschon, 2012; Reis, 2017; Viechnicki, Fishman, & Eggers, 2015). The 10 options shown were: (1) Walking, (2) Bike-sharing, (3) Public Transport, (4) Multi-modal Transportation, (5) Ride-sharing, (6) Autonomous Vehicles, (7) Scooter-sharing, (8) Car-sharing, (9) On-demand transport, (10) Personal cars. We asked the participants to sort the cards on a chart divided into 4 quadrants by 2 axes representing the level of preference and satisfaction. In a first moment, they were told to sort the cards having in mind their current daily life and as a group, then they watched the video of future mobility scenarios (Deloitte University Press, 2016) that includes all the modes of mobility and they were asked to replace the cards if needed.
In the third and last phase, we gave them 9 quotes that define random citizen approaches and common excuses that were gathered from previous studies on behaviour change (Festinger, 1985; Manning, 2009; Solomon, Bamossy, Askegaard, & Hogg, 2016; Wendel, 2014) and we asked for their interpretation about that.

3 Results and Discussion

3.1 Demands and Problems of Users

The contents collected during all three phases of focus groups were analysed for the identification of Demands and Problems related to mobility systems. As Table 2 shows, 15 topics were obtained for the demands and 19 for the problems.

Demands:
The demands were identified mostly from the analysis made to the answers to questions such as: "What do you want from a mobility system?" and "What does the best mobility system must have?". Additionally, we examined the whole conversations and interactions, looking for complaints and the reasons why the participants claim they prefer a specific mobility mode, disregarding others. We gathered the keywords and phrases.
The most referred demands were: "convenient price", "frequency", "safety/security", "space" and "speed". In short, these results suggest that users demand "cheap" or

"free" transportation, with a frequent schedule, in which "people should be able to sit" or, at least, one that is less crowded so that they don't have to "crush or push people". They would like "to go from point A to B in the fastest time possible".

Problems:

Regarding the problems, safety, security and reliability were the most mentioned issues. According to the participants' opinions, the mobility systems are not safe as should be, encompassing both robustness and reliability of the mechanical components and the associated technology, also embracing the payment process and the quality of the maintenance. About security, the participants declared they do not always trust people, referring, in many cases, to the driver or the other people co-sharing the vehicle with them. Other less frequently mentioned topics were the poor quality of the information provided on how to use the transport system. Participants state they need clear and reliable information that can avoid/reduce difficulties about understanding the routes and timetables. They also say that they often doubt the information provided is updated and/or is accurate/valid. The "Sustainability" topic was also raised during the focus groups, however, the percentage of times was quite low, this suggests sustainability was not a hot concern or demand.

Table 2. Demands and problems of users – Topic frequency

Topics: Demands from mobility	**F**	**%**	**Topics: Problems of mobility**	**F**	**%**
Convenient Price	58	13,36	Security/Trust	68	12,08
Frequent	57	13,13	Time	65	11,55
Secure	49	11,29	Demand Additional Preparation	56	9,95
Enough Space	37	8,53	Cost	46	8,17
Fast	34	7,83	People Density/No Space	42	7,46
Punctual	30	6,91	Frequency	35	6,22
Convenient Routes	29	6,68	Facilities	34	6,04
Comfortable	26	5,99	Confusing	26	4,62
Easily Reachable	26	5,99	Lack of Option	25	4,44
Reliable Information	22	5,07	Comfort	24	4,26
Clear Information	20	4,61	Digital App	24	4,26
Offer Efficient Facilities	18	4,15	Lack of Route	23	4,09
Sustainable	14	3,23	Personal Space	20	3,55
Maintained/Repaired	10	2,30	Personal Excuses	19	3,37
Clean/Hygienic	4	0,92	Traffic/Parking	17	3,02
			Maintenance/Regulations	11	1,95
			Weather Conditions	11	1,95
			Lack of Information	8	1,42
			Hygiene	6	1,07
			Sustainability	3	0,53
Total (∑)	*434*	*100%*	*Total (∑)*	*563*	*100%*

F: Frequency / %: Percentage

The statements below reflect the general perspective of users that mostly refer safety/security issues on using/sharing a given transport mode:

- "For me, everything that you have to share with people is not an option. I come from a city that is not safe, especially for a woman. I know that rape and harassment are not common here, but still, I would never take these options (sharing) in any circumstances."
- "I am kind of afraid of car sharing, I can crush a car that's not mine."
- "The only reason why I won't choose autonomous vehicles that I'm scared that something might go wrong. So public transportation is my choice, I mean, there's also a possibility that I'll crash there, but at least, I'll have somebody to follow."
- "As a woman, I wouldn't prefer it (ride-sharing)."
- "I don't feel safe in Uber. Sometimes because of the driver and sometimes because of the payment method. They take me from a long distance."
- "I don't want a stranger in my car."
- "Drivers don't like bikes on the road, they hate it."

Statements related to "time" concerns were also frequently indicated. Associated with this issue we could find some concerns with the lack of confidence in apps that, according to them, provide little credible information about timetables. In cases where the user needs to reach somewhere quickly, personal cars or on-demand transport, which were less sustainable options, were chosen immediately. The statements below illustrate the participants' time concerns.

- "I use it every day. The apps are accurate mostly but sometimes it just doesn't work. Or it says five minutes. You wait, and then the bus appears, you realize that thirty minutes passed."
- "I work in Carnaxide and to get there is terrible. It's 15 minutes by car but it's 1,5 hours by bus. If my car breaks down, I'll cry."
- "I don't want to wait 40 minutes; I'm not going to be here (bus stop) forever."
- "Big issue about walking is the time that it takes."
- "You need to download (the app for scooter), put your card number, then discover how the thing works. It takes time."
- "If I really need to go somewhere quicker, I think I would call for Uber."

Users claimed that some modes of mobility which "demand additional preparation" before the usage, cause demotivation. The need for validating tickets, waiting on queues, the necessity of choosing appropriate apparel, additional payment, downloading different brand's digital applications were the mostly stated complaints:

- "Coming to work on a bike you have to wear very comfortable clothing like sneakers, shorts, t-shirts. Sometimes you have meetings where you have to dress up so you'd have to have a place where you can put your clothes."
- "Sometimes I just want a green line, without using transport cards, validation on gates or buses. It would be so good."
- "I go to university with my computer and lots of other stuff, I can't ride a bike with them."
- "I already pay for public transport, why am I going to pay for bikes or scooters additionally?"
- "You don't have a helmet and you can be in the middle of the cars so it's dangerous. No one is walking with helmets."

- “I don’t want to change my clothes, to carry other clothes, and change it. It is so hard (for biking).”
- "Too many brands (scooter) confuses. I don't have the time to actually research and stuff."
- “If you don't have a (transport) card, you can pay to the driver but there must be a system that you should be able to pay with your credit card directly inside.”

The complaints regarding the “cost” of mobility were frequent, as the price of the rides was the primary concern of users. However, the cost was not as relevant as the other issues raised by the participants. The results suggest that if the choice was secure, fast, and did not require any extra action, the price could be considered acceptable or could be negotiated. The statements below illustrate the participants’ concerns with price/cost.

- “It'll be great (autonomous vehicles) but it also depends on the price. If they had some kind of systems like the public transport that you pay monthly and a lot cheaper, I would definitely use them.”
- “Sometimes it (scooter) can get more expensive than picking on-demand transport.”
- “I think public transportation should be almost free or free. Transportation is a right for everyone.”
- "It doesn't make sense to me that there are zones and the price is changing. I can't afford to live in the centre and I have to pay more than the people who can afford to live in the city centre. With one ticket you should go everywhere."

Another issue that was mentioned very frequently was the poor availability of public transports given the high demand, especially at the rush hours, which results in overcrowding, causing discomfort and affecting people’s choices.

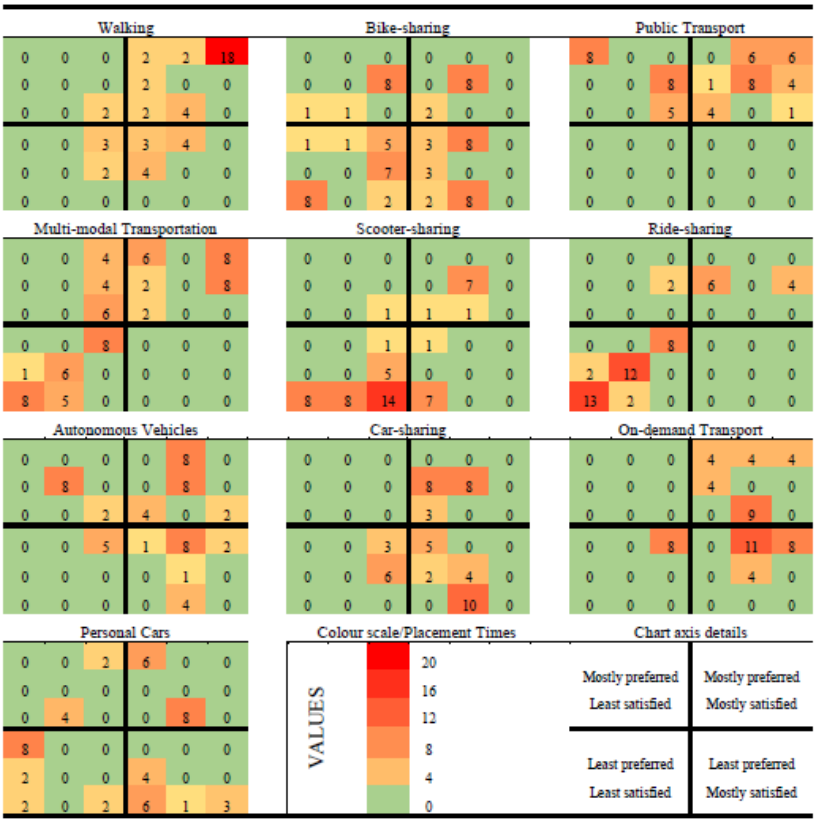
- “Rush hours are very crowded. I have to stand and I am small, so I have to travel with armpits around me.”
- “It’s so full that you cannot even get inside (bus).”
- “The anxiety when you need to get out of public transport, but you cannot because of people. It is too crowded so you have to crash or push people.”
- “There was one time I almost faint.”
- “Bus is not always great because it is crowded and uncomfortable, there is no place to sit, you just stand up and it shakes a lot.”

Other assorted problems, which could also be subject of improvement, were the number of alternative options available and their convenience, namely in terms of the routes available that not always cover the entire city or require a complex combination of alternate transports to get to certain destinations. Some participants also found the information systems (e.g., maps, timetables, signage) confusing and not as inclusive as they should be. Overall, “Hygiene” and “sustainability” topics were the least mentioned problems.

3.2 Preference and Satisfaction Levels about the Modes of Mobility

To analyse the results gathered in the card-sorting phase, we used a heat map, which provided a visual representation of the users' preferences and satisfaction level. The heat map was created having in consideration the number of cards positioned by the participants in the diverse regions of a map drawn by us, which was divided into four quadrants, employing two-axis representing preference and satisfaction.
We created heat maps per each participant and group, in two distinct moments: 1st considering the current experience with the transport systems and 2nd anticipating future experiences of use after watching the smart mobility scenario video. Table 3 shows heat maps representing the overall placement of cards.

Table 3. The heat maps of overall card placement



Overall, the heat maps suggest the users were extremely satisfied and moderately prefer the "On-demand Transport". They seem to prefer primarily the "Public Trans-

ports" and, secondarily, the "Multi-modal transportation systems". However, they were moderately satisfied with these options. The "Walking" mode attained a high preference level and was participants were slightly more satisfied with it than with the other options.

The "Sharing" modes were the least satisfying and the least preferable. Users were not satisfied with these options and barely preferred "Ride-sharing" and "Scooter-sharing". This trend gets worse when looking at "Car-sharing" and "Bike-sharing", which were the least preferred options, with poor satisfaction levels. The placement of the cards of "Autonomous Vehicles" and "Personal Car" was very divergent and we could find a clear trend there. Without more data, we can't state the reason for this result, but we can speculate that the indecision may be due to contradictory opinions about personal cars and, in the case of autonomous vehicles, to the absence of previous experiences with this type of vehicles.

3.3 The Impact of Smart Solutions on expectations about the Mobility System

As said before, we requested participants to revise their cards placement after watching a video about smart mobility solutions. The intention was to show them a glimpse of a future scenario of mobility within smart cities and collect their anticipated user-experience.

Results reveal no big differences in participants' preferences and satisfaction on most of the sharing possibilities: "Scooter-sharing", "Car-sharing", and "Ride-sharing", with exception of "Bike-Sharing", which we could observe a positive shifted. Without more data, we cannot say with certainty whether people continue to have doubts about these modes of mobility, even when they are presented in apparently perfect working condition (i.e., without most of the problems previously identified) or if the scenario presented was not credible enough to affect their assessment. Nevertheless, "On-demand Transport" and "Personal Car" preference levels got lower, which could be considered a positive change in favouring sustainability. Plus, users were more satisfied and willing to adopt "Public" and "Multi-Modal" transportation modes. Overall, this suggests, at least to a certain degree, that people are sensitive to changes regarding their mobility decisions if the system can offer a good user experience all over the journey. However, we also observed that "Walking" became the least preferred and least satisfactory option, losing terrain against less sustainable options.

4 Conclusion

This research is part of our efforts to understand users' behaviours and the obstacles that can prevent them to be engaged with sustainable mobility modes.

Understanding uses' minds represent a major challenge when designing a future smart and sustainable mobility system. The solutions that are better judged (i.e., better user experience) might have better odds to became adopted, no matter their sustainability degree. By identifying the users' concerns and demands, their biggest complaints and the problems they judge as more relevant, which can hinder their daily displacements,

this research provides informative data for designers and other professionals in different fields to develop future mobility solutions.

The present findings reveal some of the users' most relevant demands and problems about mobility modes, which need to be dealt with appropriately when designing future mobility systems. The results also show that a future smart city, at least one that fits the scenario showed, can have both positive and negative impacts on users' mobility choices. Options which are currently being suggested as good choices for sustainability, such as "sharing" mobility modes, were not appealing to users regardless of future smart possibilities. Also, improving the overall quality of transportation negatively affected the attractiveness of "Walking", which is the most advocate mode for non-motorized sustainable mobility.

Even though "sustainability" topics were mentioned as demands for mobility and asserted as a problem that must be solved, the frequency it was brought to the conversation was very low compared to other topics. This also suggests that sustainability in mobility is not yet the main concern for people. Thus, researchers, designers, and experts in related fields concerned with sustainability cannot count with much support from users currently. Which highlights the need to run more design for behaviour studies like this one, in an attempt to change the current preferences and expectations for paving a better path for introducing innovative solutions with success.

Mobility is an important requirement for social and economic development and today's culture of mobility is unsustainable (Perschon, 2012). Even though smart mobility systems, smart cities, and IoT possibilities create various beneficial opportunities for our society, the power of being able to choose to use these opportunities hold by people. Benefiting from these results, future work should concentrate on enhancing users preference and satisfaction levels of people about non-motorized mobility by finding possible solutions to their wants and needs.

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